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KETTERING ON WAR-POWER . . . Page 4

SCIENTIFIC AMERICAN

JULY • 1942

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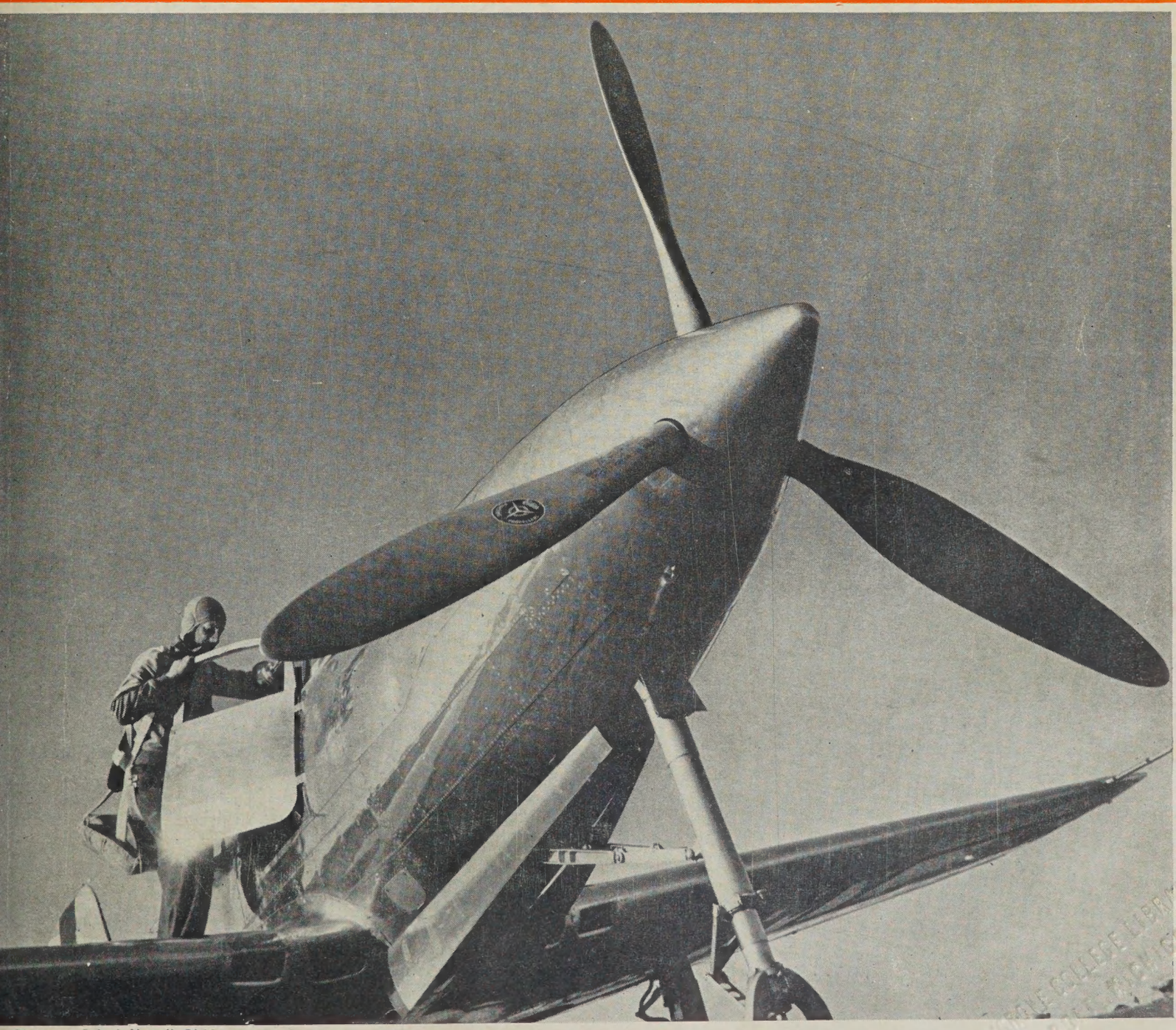

Photo by Robert Yarnall Richie

Aerial Horsepower

DETROIT

Research workers on war problems may find the answer in the following list

Metals:

Aluminum castings corrosion protection
Foundry cores
Joint seals for pipes
Aluminum drawing lubricant
Tin stamping lubricant
Nickel alloy stamping rust prevention
Metal surface protection
Drawing and stamping of nickel alloys
Sintered bearing lubricant

Paper:

Transparent coating
Waterproofing liquid
Flameproofing agent
Translucent paper
Wax coating

Textiles:

Transparent coating
Olive oil substitute
Waterproofing liquid
Textile lubricant
Flameproofing agent
Flexibilizer for cotton braid
Dye solvent
Textile emulsions
"Nylon" and "Vinyon" lubricant
Worsted and spun rayon lubricant

Ceramics:

Binder for ceramic insulation
Protective coating against mechanical abuse
Binder for vitreous enamels
Binder for abrasive wheels
Binder for porcelain enamel frit

Pharmaceuticals and Foods:

Edible emulsifying agent
Non-staining ointments
Edible fixative oil for candies
Binder for yeast tablets
Enteric Coating
Polish for tablets and pills

Adhesives:

"Cellophane" and cellulose acetate adhesive
Tissue paper to aluminum adhesive
Adhesive for rubber to cloth
Thermosetting cement

Paints, Varnishes, Colors and Pigments:

Pulp color and pigment dispersing agent
Flatting agent for paints and varnishes
Emulsion paints
Lacquer and varnish plasticizer
Soft grinding of lake colors
Increased length of pigment lakes
Non-mar enamels
Water and ink resistant lacquers

Rubber and Synthetic Rubber:

Gasoline resistant finish
Rubber gasket lubricant
Rubber to cloth adhesion
Polishing of hard rubber
Plasticizing synthetic rubber

Cork:

Cork preservative

Cements:

Waterproofing agent

Wood:

Warpage prevention
Flameproofing

Leather:

Sulphonated oil substitute

Plastics:

Plasticizer and lubricant
Polishing
Lubricant for molding

Miscellaneous:

Wax which will not melt in boiling water.

Substitute for Montan Wax, Ozokerite, Japan Wax and other imported waxes.

Dry preservation of anatomical and pathological specimens by the use of a water miscible wax.

Synthetic oils dispersible in water that do not contain soap, or added emulsifiers.

Emulsifying agent for emulsions stable to strong acids, salts and other electrolytes.

Photographic offset plates are improved, giving increased water solubility, spread and wearability by the use of a new type of binder.

Defoaming agent for casein, gelatine, shellac and similar products.

Wax which "dissolves" in hot water.

Oil which remains fluid at —50° C. without freezing.

Abrasive wheels. A temporary binder for abrasive wheels which completely volatilizes on firing.

A wax which combined with oil soluble dyes serves as a light filter and watch glass holder in the dissection of small organs and organisms.

A number of glycerin substitutes meeting specific requirements are now being marketed commercially.

Lanolin for industrial purposes can be replaced by a new compound made from domestic raw materials.

In laundering white garments, if the filler is washed out, the original stiffness and body can be restored by a new water soluble, colorless synthetic resin.

A liquid foam producer to replace Saponin for industrial purposes, is now being offered.

A hygroscopic, water soluble liquid which is an excellent dye solvent and which replaces glycerin in many instances.

Gum Tragacanth Ribbon is being replaced by a new edible gum of domestic origin.

• • •

Our laboratories have developed solutions to these unique problems. The answer to these and many other problems are given in a 112 page manual of chemical formulation for numerous industries. A copy of the manual "Chemicals by Glyco" is yours for the asking. Send for it today. You may find the answer to your war-time problems.

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"HORSEPOWER is Warpower," see page 4, is symbolized by our front-cover illustration of an Allison-powered plane of the United States Army. This striking photograph was made by Robert Yarnall Richie and is reproduced through the courtesy of the Curtiss-Wright Corp., Propeller Division.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1892)

PATENTS—"Disparagement of patents is common and easy but it should not be forgotten by those who sneer at inventors that, out of a total of over $8,000,000,000 of capital invested in manufacturing in the United States, patents form the basis for the investment of about $6,000,000,000. Evidently, the United States system of encouraging invention that has resulted in the patenting of over 475,000 inventions, is a system that is exceedingly wise and valuable."

CENTRAL SCREWS—"A new ship has just cast anchor at the Louvre wharf—the steamer *Louvre,* built by Mr. Oriolle of Nantes. When loaded it sinks but 2.8 meters in the water, and is consequently capable of ascending the Seine with a full cargo. This quality is not the only one that makes a truly

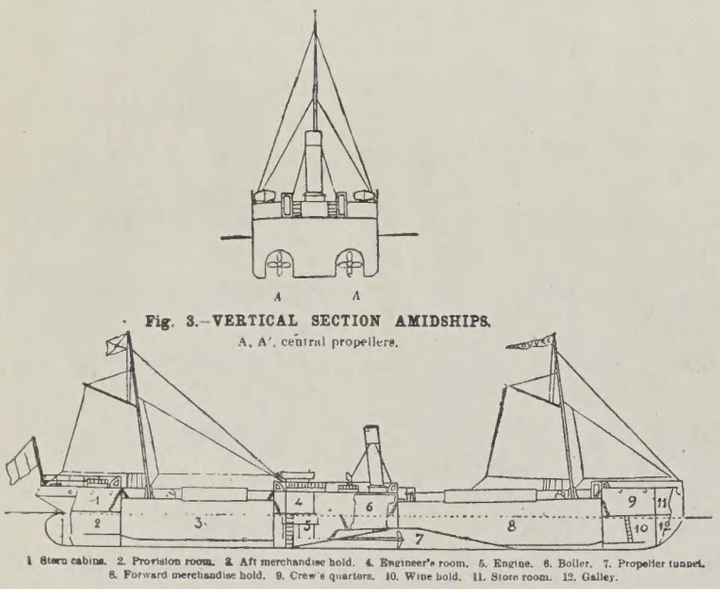

Fig. 3.—VERTICAL SECTION AMIDSHIPS.
A, A', central propellers.

1. Stern cabins. 2. Provision room. 3. Aft merchandise hold. 4. Engineer's room. 5. Engine. 6. Boiler. 7. Propeller tunnel. 8. Forward merchandise hold. 9. Crew's quarters. 10. Wine hold. 11. Store room. 12. Galley.

original ship of the *Louvre*; it is the first ocean vessel provided with two central propellers . . . These two propellers are placed a little forward of the center of the vessel . . . Each revolves in a sort of tunnel having the form of an inverted U . . . The propellers, which are 1.8 meters in diameter, and of 2 meters pitch, in revolving suck the water in front and force it aft. As the tunnels are not closed at their lower part, the cavities that they form on each side of the center of the vessel increase the stability of it."

WRECKED—"The schooner Henry B. Tilton was recently wrecked off the United States Army Ordnance Proving Grounds, at Sandy Hook, by a 575 pound projectile which went astray after leaving the muzzle of a 10-in. breech-loading rifled cannon. The projectile struck the vessel on the starboard counter, crashed through her longitudinally as if she were an eggshell, and before the crew realized that the craft had been struck, the water poured in through a great splintered hole in her port bow, where the shot had emerged."

AIR LOCOMOTIVES—"A compressed air locomotive is reported to have been successfully used for several months in the interior of the Old Eagle Mines, near Pittsburgh. . . . Generally the construction is the same as a steam locomotive, with the omission of the boiler and water tank, these being replaced by two large cylindrical tanks holding the compressed air. . . . The locomotive carries air at 500 to 600 pounds pressure but ordinarily the pressure varies from 250 to 450 pounds. . . . If charged to 500 pounds, the engine can make a distance of 1 1/3 miles, doing heavy work, and it is practicable to make a running capacity of 4 miles with one charge."

SHIP BUILDING—"On account of the contracts undertaken by the Union Iron Works in the building up of our new Navy, the establishment now occupies a position of much general interest. Here in South San Francisco were built and equipped the highly successful cruisers *Charleston* and *San Francisco,* and here also was built the monitor *Monterey,* now receiving her finishing touches, and being supplied with what are believed to be some of the most perfect of high-powered guns yet made anywhere. In addition to this work there is now on the ways one of the largest of the new battle ships, the *Oregon,* to have a displacement of 10,000 tons, and to cost, exclusive of armament, nearly four million dollars."

CABLE—"The United States survey steamer *Thetis* arrived at Honolulu on May 20 from Hilo, where she ended the survey for the cable to be put in between San Francisco and the Hawaiian Islands. The course to Hilo comprised 2,060 miles. . . . The soundings were made at intervals of two, ten and sometimes one mile apart. The deepest was 3,228 fathoms, about 245 miles northeast of Hilo, and the shoalest was 976 fathoms, at a point about 350 miles from Point Conception. Were it not for this abrupt rise, the course would have been almost level."

TEMPLE ROCK—"For more than 2,000 years, a dressed stone containing 12,922 cubic feet—being 71 by 13 feet in size—has rested on pillars in a quarry of Baalbac, in Syria. It was intended for the foundations of the temple of the sun, a mile or more distant, to which four stones nearly as large were actually transported."

GUM CHEWING—"It is a curious fact that in England they do not chew gum but rather look down upon the habit as being vulgar, and of the small quantities that have been shipped abroad, but little has been sold. The time doubtless will come, however, when this democratic habit will overcome the prejudices of our cousins across the water . . . Already Australia has thrown up her hands, and decided that gum is a necessity, and American manufacturers are working that market for all it is worth."

CAMERAS—"While it may be too early to say the old-time plate-holder camera has had its day, it cannot be denied that magazine cameras of various kinds are superseding the old-fashioned camera, especially among tourists and others who desire to accomplish a great deal photographically in a very short time."

AURORA—"Experiments made at the Royal Danish Academy have demonstrated approximately the height of the aurora borealis. M. Adam Paulsen, at Godthaab, by means of two theodolites situated four miles apart, found that different aurora displays varied from one to four miles in height. Experiments near Cape Farewell showed the height of different auroras to vary from one to ten miles. At Spitzenberg the range of height was from one-third to eighteen miles."

OUR *Point* OF VIEW

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MASTER SCIENCE — IN WAR, IN PEACE

As MOST middle-aged and older readers will recall, the chemists were the fair-haired boys in World War I. Today, in World War II, the fair-haired are the physicists —exalted to the level of a kind of war nobility. As the chemist, President Conant of Harvard, has said, it is a physicist's war. (In fact, the chemists are being treated shabbily. The secretary of the American Chemical Society, Dr. Charles L. Parsons, states that several hundred chemists and chemical engineers, including some with seven years of training and additional years of experience, have been inducted into the Army and are now functioning as stretcher bearers, orderlies, pharmacists' clerks—their costly training lost to the nation. These tragedies have been caused by local draft boards which probably don't fully comprehend that a chemist is a basic tool of industry. Yet all efforts to remedy this situation have completely failed, in spite of the fact that the entire matter has been forcefully presented to high authority. This is a physicist's war but chemists still are highly vital to its conduct.)

Day and night, behind locked doors and under watertight oaths of secrecy, the majority of this nation's outstanding physicists are hard at work at what may prove to be the key to the war effort: Canny applications of the interactions of matter and energy—that is, of the science of physics—directed toward the single aim of cracking Hitler.

In the systematic search for the ablest physicist workers, the personnel of physics has been combed over again and again, and now the nation is to be fine-tooth-combed for physicists of lesser degree clear down to the rank of high-school graduates and even below that. Officers and faculty members of high schools are being officially urged to single out youths who have shown innate aptitude for physics and its working tool, mathematics, and to direct their interests more actively into these channels with two ends in view: the help which these youths may later (but not much later) lend to the war effort, and their own peacetime futures in the one science which now seems most likely to be the great science of the future.

Just why is World War II so greatly a war of physics, and in what exact ways are the physicists so close to the core of it? This can be told only approximately at present and, for the rest, the answer must be simply: Hush. Let the War Policy Committee of the American Institute of Physics, representative of the whole body of American physicists, state it: "The present and potential contributions of physics may well have a profound effect on the outcome of the war because new tools have been devised which can swing the tide of victory. These tools utilize results of research in electronics, electric waves, acoustics, mechanics, and optics. Physicists have devised them, and engineers have shaped them for manufacture, and manufacturers are producing them." Top physicist of those who are participating in these defense—or rather, offense —research efforts is Dr. Vannevar Bush, Director of the Office of Scientific Research and Development (OSRD). He has commented on this question most succinctly: "OSRD members listen and do not talk."

As long ago as last October three fourths of the outstanding physicists were heading OSRD research projects for war offensive uses. Since December 7 that percentage has run steadily upward and the need for physicists now increases at the high rate of 1500 to 2000 per year.

In addition, there now is a special need for 100,000 or more individuals who, while not full physicists (eight years of training and experience), are well enough schooled in physics and mathematics to accept training in technical war operations. This is why the governing body of American physics urges a search among ordinary student bodies—college undergraduates and high school—for those who have innate aptitudes in these subjects. (Mathematics is the most important tool of physics.) Our readers may do a service in helping to sleuth out such youth and perhaps influence them, not only to help now, but, if they prove to have special abilities required in large enough measure, to become physicists for life.

Here one may well inquire about the moral responsibilities involved in influencing another's life. Will physicists not become worth but a dime a dozen after the War? Admittedly, some temporary helpers will, but those of them who prove to be born physicists never will. For the physicist—the first-class or research physicist—has a mind and makeup which simply cannot be made to order. To begin with, it must be decidedly a first-class mind. Then an analytical mind. Objective. Free from emotional bias. Capable of dealing in abstractions. In addition to these there is a something, often remarked by scientists—a matter largely of attitudes and outlook. The born physicist is in part detached from reality—he lives in an ivory tower. This explains why he is not well understood by practical people and why he stumbles across so many impractical findings that later turn out to be eminently practical. His mind is altogether free. It soars, though under full control. Sometimes the physicist's mind seems to conventional minds just slightly crazy—usually a matter of wrong emphasis! Crazy like a fox.

A youth who exhibits some aptitude for physics but not enough to become a peacetime research physicist will not in any event have wasted his time. As the Institute of Physics states: "The study of physics (irrespective of any post-war career) is immeasurably helpful in any walk of life, because such study improves the ability to understand the new physical environment which man is creating for himself, and which, far more even than now, is bound to exert a major influence upon social, political and economic trends. Great new developments now appearing behind the veil of secrecy are, beyond all possibility of doubt, establishing the basis for unprecedented peacetime applications of physics in industry. Some of the greatest of these are along lines not yet developed as branches of engineering. They give promise of opening large and fruitful fields for the useful and profitable employment of those well equipped with a broad, fundamental training in physics." In Scientific American last May, Dr. E. U. Condon, Associate Director of the Westinghouse Research Laboratories, explored phases of the same general subject. First-class research physicists can never become a dime a dozen: They are counted only by dozens.—*A.G.I.*

98TH YEAR SCIENTIFIC AMERICAN JULY 1942

HORSEPOWER IS WAR POWER

How American Industry is Powering Our Military Machine

CHARLES F. KETTERING
Vice President of General Motors Corporation, in charge of Research

TODAY'S machine war is horsepower war. It is important for Americans to remember this, because we have available more horsepower per individual than any other nation on earth. We are the world's largest producers and consumers of horsepower. We produce enough power in peacetime to supply 15 horsepower to every man, woman, and child from Maine to California and from Canada to the Gulf. Automotive engines alone supply more than 65 percent of this horsepower in peace.

With the coming of war the power available per individual is stepped up to even greater quantities. For every soldier in a modern mechanized division there are 32 horsepower behind him, twice as much as in time of peace. We call this the machine age; we really are living in the horsepower age.

One of the most important things about horsepower is the fact that man by himself possesses so little of it. While the strongest athlete can exert as much as two and a half horsepower for perhaps a minute at a time, he is good for only about one tenth horsepower in sustained effort. The fact that this amount of power is barely sufficient to turn a 12-inch electric fan will give you some idea of what a small amount of power we can produce by our own muscular effort. Just to make your toast in the morning requires more power than five able-bodied men can generate by turning an electric dynamo. The American housewife, although she probably never thinks of it in this way, has in her home the equivalent of at least 60 servants in electrical appliances to do her bidding. If we add to these 60 servants the 75 or a 100 equivalent horses stabled in the family garage, we see that the typical small American home can boast a staff that would certainly have been the envy of any Medieval castle.

Naturally, these tireless, obedient, reliable servants did not spring into being by magic. There are years of trying and failing and trying and failing and of slow, patient accomplishment behind every one of the thousand little conveniences which we today accept as a matter of course. Our conveniences are the concrete result of industrial research in action.

Since before recorded history man has searched for means of augmenting his puny one tenth horsepower. The lever, the inclined plane, the screw, the pulley, and the wheel provided him with the means of extending the usefulness of his natural muscle power, but they did nothing to increase it. These five fundamental devices, upon which all machines are based, may be considered as extensions of man's facilities, just as the first stone he threw was in effect an extension of the striking power of his arm. In the same sense, the sling which David used with such effectiveness against Goliath, the long bows with which the English farmers routed the French armored knights at Agincourt, the crossbow, the catapult, and the battering ram were simply extensions of man's own muscle power.

THE first significant increase in the amount of power which man brought under his control came when he learned to domesticate animals. With the domestication of the horse, man increased his power tenfold, and he took the first step toward becoming a controller rather than an expender of power. There are few animals that have not at one time or another lent their muscle power to the tasks man proposed. Even the bird—usually thought of as the freest of all creatures—was conscripted to his purposes, carrier pigeons supplying the original airmail service. Hannibal was among the first to use this new source of animal power for war. The elephants with which he startled the Romans in 218 B.C. were simply the forerunners of the present-day tanks. Later, Ghenghis Khan — still the champion conqueror of all time—swept westward through Asia and Europe with great armies mounted on Mongolian ponies. But even more important than his cavalry, Ghenghis brought with him a fantastic new toy, the Chinese firecracker.

HERE was an altogether different source of power. There was nothing muscular about it. A small child could set off, as easily as a grown man, a charge of sufficient force to blow up a whole fort. It was entirely unlike anything that had existed before. Man had discovered how to harness the terrific energy of a chemical reaction. While he had increased his power tenfold by taming the horse, he was now able to increase his power a hundredfold or a thousandfold by taming the chemical animosity of saltpeter, sulfur, and charcoal.

There was another significant aspect to the discovery of gunpowder. Unlike the wind man had used to propel his boats or the water he had used for pumping or grinding grain, gunpowder provided him a form of power that was extremely compact and mobile, that he could use whenever, wherever, and however he wanted it as long as he kept it dry. This becomes especially significant when we understand that the internal combustion engine is simply a first cousin of the cannon. As a matter of historical fact, the first internal combustion engine was a gunpowder engine invented by Christian Huygens, a Dutch scien-

tist, in 1680. There is no essential difference between a cannon and the cylinder of a modern gasoline engine. The piston is simply an adaptation of a shell with a connecting rod attached to it in such a way as to restrict its movement and provide a means of transmitting its power. And the reaction of gunpowder in the presence of heat is no different from the reaction of gasoline in the presence of the spark from a spark plug. You can say that the automobile you drive is run simply by six rapid-fire cannon arranged in such as way as to give you a smooth flow of power at the wheels.

The development of the gasoline engine followed naturally from the discovery of gunpowder. The horsepower which one man could control and direct to do his tasks had now grown to enormous proportions. Manpower, particularly in warfare, had become a relatively inconsequential matter. The French army was certainly numerically superior to the German, but the *panzer divisionen* was as radical an innovation in horsepower as Hannibal's elephants or Ghenghis Khan's ponies. German airpower was numerically superior to the British, but last fall's scheduled invasion of Britain failed because a few Spitfires and Hurricanes had enough well-utilized horsepower to hold off a greater number of Messerschmidts and Stukas.

The soldier of today is still a puny one tenth horsepower machine, but he now uses his one tenth horsepower to direct the greater horsepower which these new weapons have given him. He is like the tiny grid impulse which regulates the heavy plate current of a vacuum tube so that the sound of a pin drop can be amplified and magnified until it booms like a clap of thunder.

Tanks, trucks, planes—millions of horsepower

World War I was simply a great proving ground for two power-using weapons—the tank and the airplane. As with every new thing, no one foresaw the possibility that these two weapons would entirely change the existing methods of warfare. Land war had become a contest of endurance between large masses of troops in trenches. All movements were made slowly and in one plane of activity. Because the general acceptance of a new thing is always slow, no one realized that these two weapons, which augmented the feeble power of the foot soldier with that of the internal combustion engine, at once made it possible for him to move swiftly and in any direction he chose. The airplane took the lid off every fortress and island in the world.

Then one man who did not know anything about engineering completely changed our ideas of a fixed warfare and made us accept these new weapons for what they are. He started a program to build 20,000 tanks and 20,000 airplanes and even wrote a book telling people exactly what he was doing. Everyone said he was crazy. When he finally got his 20,000 tanks with from 100 to 400 horsepower each and his 20,000 airplanes with 1000 horsepower each, he was able to substitute horsepower politics for ordinary diplomacy. So far, horsepower has won every battle. Now our job is simply to produce more horsepower than he can.

Time will show that the Axis picked the wrong opponent when they picked the United States to fight a horsepower war. We have the greatest power-producing facilities in the world. The automobile industry, for example, has produced over 80 million vehicles since 1900. If we say that each of these averages 50 horsepower, which is a very conservative rating, we see that we have produced four billion horsepower for use on our highways alone. In one average year we have produced over 200 million horsepower. We have about 40 million horsepower installed in electric power plants. These plants light our homes, streets, and factories; they provide power for our industries; they distribute electrical energy for our great communication systems. In a hundred ways they furnish the power to make our American way of life possible. Forty million horsepower is a lot of power, but it is less than one fifth of the amount of power the automobile industry turns out in an average year. In other words, it takes us less than three months to duplicate all the power production of all the electric power plants in the country.

When military men ask for huge totals of power to win the war, they are not speaking in unknown terms to the automobile industry. When we needed 200 million horsepower a year to keep our American way of life in peace, industry produced it. We have learned, better than any other country, the mass production of power. Every bit of this accumulated experience, together with all the resources of management, machinery, and labor, is being used to produce more and still more horsepower to win the war.

Let us examine the difference between a division in World War I and a modern mechanized division and see if we can gain some idea of the magnitude of the job industry is called upon to perform.

The old division used 4400 horses and 153 motor vehicles of about 3500 total mechanized horsepower. The modern mechanized division, with fewer men, has 2700 vehicles ranging

in size from the motorcycle to the heavy tank. More than 400,000 horsepower are available. The old division moved at 3 or 4 miles per hour with 25 miles a long day's advance. The increase in power of the new division gives it a speed of from 25 to 60 miles per hour, and it can easily travel 250 miles in a day. The old division required 39 tons of ammunition per day. The new one 600 tons. No wonder the *panzer divisionen* struck such terror in the hearts of the French soldiers.

This 400,000 horsepower represents the effort that could be exerted by 4,000,000 men. And the mechanical equipment —tanks, trucks, jeeps, peeps, and motorcycles—are no more tired at the end of a long day's advance than they were in the morning. The mechanized division is made up of about 12,700 men and officers with an average of 32 horsepower available for each man. This power is used to increase the soldier's speed and mobility, carry more and heavier guns, and allow for heavier armor to protect him in battle. Each man has available an average of the combined power of 320 men. In a tank, he may have the equivalent of 1000 men acting from his orders.

Many of the vehicles necessary for a mechanized army are now being produced in large quantities and have been for the last year. Other and newer types will soon be in large scale production. For a long time the army has worked with industry to build the vehicles that will be necessary. As we have repeatedly pointed out, it takes time to get an entirely new product into production. Even with industry's great skill in methods of producing horsepower, it does take time to get through the "tooling up" stage. Now that industry is gearing itself to the wartime pace, it is producing horsepower in ever increasing millions. It is easier to criticize others for not doing more, than it is to do. A critic doesn't have to convert a plant overnight from peacetime to wartime production. He doesn't have to design and build tools and dies, make production schedules, train workmen, meet government specifications, and build a product that will pass the rigid inspection of the Army and Navy. And all the while he is working he does not have to be on his guard against talking about his accomplishments. The results are a military secret and have seldom been released. This is entirely as it should be if we are to prevent valuable information from getting to our enemies.

Let us go further and show what this war of horsepower means in the newest form of fighting machine, the airplane. Here the figures are just as astronomical as they are in the mechanized army division.

In World War I, a basic training plane used a 90-horsepower engine. This engine, the Curtiss OX-5, became the standard power for "barnstorming" after the war. The OX-5 engine weighed 375 pounds, or more than four pounds per horsepower. Today a basic trainer uses a 200-horsepower engine weighing about 400 pounds, or two pounds per horsepower.

The author studies a new GM Diesel

THE most outstanding development has, however, come in the high-speed pursuit airplane engine. In World War I, the Liberty engine gained world fame and was to have become the standard high-output engine of the A.E.F. This engine developed 400 horsepower and weighed approximately 840 pounds, or more than two pounds per horsepower. It was just about the same size as the present-day liquid-cooled Allison engine which develops 1325 horsepower at less than one pound per horsepower. The development of the Allison engine was started by industry in collaboration with the army early in 1930, and it was just about ready for production when we needed it.

Far-seeing men in the United States Army asked industry to undertake this development even though there seemed to be no immediate use for the engine at the time. What is important to us now is that all the preliminary work was completed when the engine was needed. There is no way to speed up such development. Two hens can't hatch a setting of eggs any faster than one can. This is a fundamental factor that many people overlook.

The development of this new liquid-cooled engine has meant much to Army aviation. As a result of this development it was possible to increase the speed of a pursuit plane as much as 60 miles per hour on the same number of gallons of fuel per hour. It has taken only two years to increase its power from 1000 to 1325 without any significant change in the design, and this may be increased even further.

What does the huge air force the President asks for mean to us? He wants 60,000 planes in 1942 and 125,000 in 1943. Industry is being called upon to produce in excess of 100,000,000 horsepower this year and in excess of 200,000,000 in 1943 to power these planes. Let us do some more comparing and see what these figures mean. In 1942 we will have to produce as much power in aircraft engines as the combined power of all the railroads of the country. In 1943 we will have to double it. And this power will be for airplanes alone. We already have a good start. One company alone is producing over a million and a half horsepower a month in a factory built where there was a vacant corn field only a year ago.

Today a pursuit pilot has from 1000 to 2000 horsepower to pull him through the air at speeds well in excess of 400 miles an hour. In World War I the 400-horsepower engine pulled him only about 120 miles per hour. Several developments have taken place to make these increases possible. First, the aeronautical engineer has learned more about the aerodynamics of the plane itself. Better wing sections, streamlining, better materials, the reliable monoplane, retractable wheels, and dozens of other improvements have increased speeds.

But there is a limit to the increases that can be made by aerodynamics alone. It takes horsepower to fly at speeds of seven miles a minute. An engineer would say that the horsepower required goes up as the cube of the speed. In layman's language

Two Diesels operate this mobile power plant

Allison airplane engines being packed for shipment

this means that to get twice the speed we have to supply eight times the horsepower. Now we see why horsepower is so vital in obtaining air supremacy. Power means speed.

Fortunately engineers and chemists have given us the means of obtaining increased power from a given size engine by the development of better fuels. This means any engine that burns gasoline as a fuel, whether it drives an automobile, truck, tank, airplane, or motorboat. High octane fuel makes our present high-output engines possible whether they are used for peacetime purposes or for those of war.

THE story of high octane fuels has been told many times. The work grew out of my attempt to burn kerosene in a Delco Light engine long before we got into the First World War. The improvements which we effected in the fuel were made available to the automobile driver early in the 1920's. Since then improved fuels have been responsible for doubling the power we get from an automobile engine. Every driver of a car in the past 20 years has benefited from this development. It was a research project carried on by private industry and made available to motorcar owners in peacetime.

The dividends which this single development has paid to our country have been enormous. The automobile owner has saved about 25 percent of his fuel bill. This amounts to a billion dollars a year. It means also that we have conserved our natural resources. Better fuels have been responsible for just about doubling the output of a given size engine. It has been said that this has increased the installed power of automobiles by about one billion horsepower.

The T.V.A. is one of the foremost of our great power developments. This series of dams will produce about three quarters of a million horsepower, or less than one thousandth of the power gained by the use of better automobile fuels. If all our automobiles were to develop a "miss" in one cylinder at the same time, we would lose ten times the installed horsepower of all the T.V.A. dams together.

But what is extremely important to us at the present time is the fact that without these better fuels such powers and speeds as we require from our military planes would be impossible. It is not surprising that one man high in government office has said that high octane fuels may be the most important single factor in the outcome of this war.

In World War I the Liberty engine had to be designed to run on 50-octane fuel, the aviation gasoline available at that time. The Allison engine utilizes 100-octane gasoline. The difference between the 400 horsepower of the Liberty engine and the 1325 horsepower of the Allison engine is largely due to this difference in fuel.

Because American industry conducted research during peacetime, we are the only country in the world with the capacity and the know-how to produce 100-octane fuel in adequate quantities for our military airplane engines. Fuel research has already added millions of horsepower to our armed forces.

A number of years ago we started a research project with the aim of developing a high-speed, light-weight Diesel engine. We had long hoped that we could bring the benefits in economy of the Diesel to the small engine field. We did not have any particular application in mind, for we knew that any new and better means for developing power would find hundreds of users. Others would put the power to work.

In a few years a new type of two-cycle Diesel was introduced at the Century of Progress in Chicago. That was in 1933. The next year this type of engine was used to power the first of the new high-speed Diesel-powered streamlined trains. Likewise, the Navy had adopted it for submarines. This development of industrial research conducted by American industry in the regular course of its business has been found to be the answer to many naval and military problems. Continued research has resulted in still smaller and lighter high-output Diesels. This family of engines is now powering naval craft of many kinds, large trucks and buses, tanks, and mobile power plants, all for war purposes. Here is an industrial research development which is useful either in peace or in war. The engine doesn't care what it is used to power.

ONE of the most important peacetime uses of the Diesel was in the new 2000- to 6000-horsepower locomotives. This engine has revitalized the railroads and more Diesel locomotives are being built than any other type. These efficient engines, which have speeded up switching, passenger schedules, and freight shipping, are of extreme importance in time of war. We are deriving unexpected benefits from the speeding up of our war material deliveries made possible by this peacetime development. Diesel locomotives may even speed the deliveries of the same type of engine to be used by our Army or Navy for other defense purposes.

We are in a war of horsepower—of Allied horsepower against Axis horsepower. The victory will go to the side which has the most and the best horsepower producers. American industry, which has produced the most peacetime horsepower, is now producing the most wartime horsepower. Our front lines are the engineering departments, research laboratories, and factories. Able and experienced

management, skilled workmen, and engineers second to none are holding these lines. All our efforts are geared to produce power and more power for the armies and navies of the United Nations.

This is a civilization of horsepower as well as a war of horsepower. When the engines of war have fired their last charge of fuel, the engines of peace will immediately start their job of rebuilding. We will not only beat the sword into the plowshare; we will convert the tremendous horsepower of war into the useful horsepower of peace.

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TIN PLATING

Thinner, More Economical

By New Process

BOTH tin and electric power will be conserved by a faster, more economical electrolytic process for plating strip steel with tin, announced recently by the Electroplating Division of E. I. du Pont de Nemours & Company. Known as the Halogen Tin Process, this process employs a neutral solution which is said to eliminate sludging and the consequent waste of tin common to many electro-tinning methods.

Strip steel for containers can be tin-plated twice as fast with less electric power by this process as by the "alkaline" electro-tinning method, it was stated, thereby reducing substantially labor and power costs. A thinner, more uniform coat of tin can be applied to strip steel electrolytically than by the conventional "hot dip" method, resulting in savings of from 40 to 65 percent of the tin used.

A larger percentage of tin cans henceforth will be plated by electrolytic processes because the War Production Board has limited drastically the amount of tin for containers, and thin coatings of the metal will be necessary. Tin deposited by the Halogen process, it was said, can be heated without discoloration either when tinplate is heated to obtain the bright finish required by some can manufacturers or when treated during the process of applying lacquers or enamels.

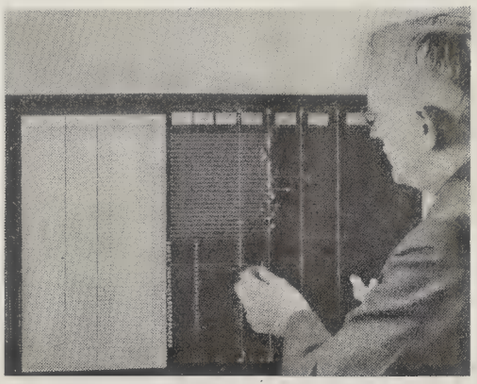
CONTROL

Of Production With

New "Scoreboard"

BUSY industries in every classification, working on both war and civilian orders, are making use of a new system called "Produc-Trol" which enables production and purchasing executives to see quickly all facts concerning raw materials, parts, assemblies, machine and man hours. Information of this kind is especially essential where multiple-shift production is maintained.

"Produc-Trol", which was developed by the Wassell Organization, lists parts, assemblies, sub-assemblies, or individual operations at the left of the board shown in one of our photographs. Movable tapes working from left to right on pulleys bring all pertinent facts into instant focus. Double rows of peg holes under the movable tapes, and various colored pegs, permit many arrangements of comparative data and control, required for any operation. Units can be obtained in sizes to fit specific needs; models are also available for individual and group-incentive plans.



Keep tab on production

• • •

MODERN INDUSTRY—Fifteen of the nation's major industries have been developed in the last 62 years, creating work for about 15,000,000 persons.

• • •

METAL FINISH

To Substitute

for Plating

A COLORED transparent finish for use on polished metal, and which is unaffected by war-time restrictions, is being produced by Maas & Waldstein Company as a substitute for electroplating and bronze-powder finishes.

This finish, which is marketed as "Platelustre," consists of a concentrated enamel, of the desired color, added to a clear lacquer. When applied on polished metals, it makes them resemble copper, brass, bronze, color-treated aluminum and steel, or other metals.

It is applied by spraying or roller coating and can be furnished for either air-drying or baking. Flat stock finished with certain grades can be formed after baking. The colors are fast to light in indoor service, the manufacturer states.

CONVERSION

Of Machine Tools Calls

For Fine Ingenuity

CALL it automotive "know-how" or call it conversion, the automotive industry has been faced for more than a year with the task of ingeniously adapting equipment for war jobs.

It was ten months or so before Pearl Harbor when one automotive concern, for example, agreed to produce parts for an anti-aircraft cannon In the loader mechanism of the gun, the automotive engineers and master mechanics found the greatest challenges to their ingenuity. This unit is an assembly of parts, most of which have to be machined in curves that are small segments of circles that range up to 86 inches in diameter.

Under normal conditions such cuts could have been made easily by huge milling machines with enormous rotary tables. But the smallness of the original order ruled out the possibility of using such special purpose machines. So an ingenious device was made—a fixture attached to an ordinary standard-type milling machine. It resembles a wedge of pie.

At the point of their "wedge of pie," the designers placed a fulcrum equipped with hand-screws. With this they could swing gun parts, clamped to the "piecrust," against the milling cutters.

With such unorthodox fixtures, most of the curved parts were machined for the original orders. And, having mastered the "know-how" on these ingeniously adapted machines, the master mechanics were prepared for the change of pace induced by the Pearl Harbor attack. The crisis brought the first large order for guns. They then transferred their "know-how" to similar adaptations of huge automotive rotary milling machines. These were torn down and rebuilt to make radial cuts in the large quantities required.

One of the large machines is now cutting radial loader parts, 17 at a time, out of huge hoops of bar steel.

Though no longer needed for the jobs they performed so ably, the small machines with their "fan-tail" fixtures have not fallen idle. Moved to another department, they are now executing radial cuts on curved airplane parts.—*Automotive War Production.*

INDUSTRIAL TRENDS

RESEARCH PAYS NOW . . . AND LATER

SUBSTITUTE the drive of life-and-death necessity for the dollars-and-cents motive, and there appear amazing results from the research laboratory. That is exactly what is happening in many industries today, particularly in the automotive industry where production is all-out for war and not at all for the civilian consumer who has been the basis on which the industry has been built. In the calm days of peace-time activity, when the prime interests of the industry are to make a better product than competitors and at the same time show a reasonable profit, many of the findings of the research laboratory are at least temporarily shelved because their adoption would be too costly. But when the wheels must turn for military purposes and the profit motive is thrust into the background, the laboratory technician is in his scientific glory; no longer are costs the bugbears that hinder his development work. His main objectives now become the finding of new ways of doing things better and of new materials that, substituted for old ones, are at least as good as or better than the originals.

Before we become specific about this sort of thing, let it be understood that what has been said is not to be taken as an indication that war-time production is being used as an excuse for being wasteful. Far from it. But there is a definite job to be done and all too little time in which to do it. Under such conditions, many of the peace-time rules of industry are thrust aside and barriers are overcome by means that, given other circumstances, would throw the average cost-accountant into a quiet case of jitters.

Here's where it all stems from: As is too well known to bear repetition, there are real shortages in certain materials formerly considered indispensable in the automotive industry. Before the war—how long before makes no particular difference in this discussion—there had been developed many substitute materials for these indispensables, but they had not been put into production for economic reasons. Military approval of a substitute, however, ordinarily demands that the substitute be much more than a mere alternate. It must do its given job as well as the material formerly used; if possible, it must do that job better. This, indeed, is just what many of the shelved results of many research laboratories will do. So now these shelves are being cleaned off, their contents are being brought to light, and the labs are working night and day to produce the wherewithal for the production lines of victory.

Here are some cases in point, gleaned from *Automotive War Production:* Alloy steels containing carbon and molybdenum are superior substitutes for steels using nickel, chromium, and other scarce alloying metals, but these carbon-molybdenum alloys require heat-treating processes to bring out their superior physical properties. This heat-treating is too costly for ordinary commercial production in times when other alloying materials are cheap and plentiful. But when the life-and-death motive takes charge of the situation, all such considerations fall by the wayside. Thus, one company making small combat vehicles has saved 41,000 pounds of nickel on one contract by using these steels that research had produced but which had formerly been almost a laboratory curiosity. In another similar type of substitution, copper-silicon castings were substituted for the formerly used copper-tin alloy in the manufacture of anti-aircraft guns; net saving was 20 pounds of tin per gun.

Then there is the case of sheet steel, one of the forms of metals that has relatively little use in wartime production. A shell clip was formerly made by die-casting aluminum. It was decided to change the design and to use sheet steel. Result: An improved clip and expanded use of sheet steel, together with employment of men and machines that work this material. Also, the change-over in this clip alone is reported to have saved, to date, $2,000,000.

Metals are by no means the only materials which are receiving the utmost attention of researchers. Leathers, fabrics, and felts have been developed as alternates for the rubber and synthetic rubbers that were formerly used in anti-squeak pads, bumpers, gaskets, and seals. Plastics have been put into service in steering wheels, replacing the hard rubber formerly used. Other similar plastics, in extruded form, have found application in cooling-system and other hoses. Battery boxes of molded natural asphalt found in Utah are releasing still more rubber.

And so it goes. To summarize: In one combat vehicle, original plans called for 12 pounds of rubber, exclusive of tires. Alternate materials have cut this rubber requirement to one half pound. Another vehicle has been redesigned to use alternates, with the result of saving more than 16 pounds of rubber and almost five pounds of nickel per unit. These brief figures give a graphic idea of what has been accomplished. What this trend — and it extends throughout all phases of vehicle design and construction —will mean to the post-war automotive industry is quite obvious. No one knows today what the civilian automobile will look like when the industry starts after customers instead of after Japs and Nazis, but we can all rest assured that it will have better materials and greater efficiency than ever before.

DIAMONDS OF INDUSTRY

ALTHOUGH the use of diamonds in a variety of industrial tools is not by any means new, such tools as were used in the United States were largely imported from Europe until the outbreak of World War II. Now, faced with the need for precision machine work in so many war industries, diamond cutters and merchants in this country are turning to this outlet for their products and are building a business that is one of the most rapidly advancing industries of the moment. It is worthy of more than passing notice, also, that jewelers are advocating the purchase of gem stones for personal adornment on the ground that the by-products of cutting such stones are small diamond chips which can be used in industrial tools. Thus, they argue, the more gems purchased, the more chips there will be for use in the war effort and, at the same time, the less costly will be these same chips to those who need them.

But larger sales of gems is not our concern: What is more important to the trends of industry is the fact that industrial diamonds are needed and are being supplied in ever-increasing quantity and for ever-expanding uses. Because diamonds are the hardest substance known, they are widely used not only in grinding tools but in dies and gages as well. So hard is the diamond, in fact, that dies and gages are being supplied to industry today with guaranteed tolerances of hundreds of thousandths of an inch; in some cases with no tolerance at all! With such American-made tools available, all industries demanding high precision can put their best efforts forward.

—The Editors

Synthetic Elastomers

How Molecules are Manipulated to Make New Rubber-like Materials in Unlimited Variety

SIDNEY J. FRENCH
Professor of Chemistry, Colgate University

■ **In our April 1942 number Professor French explained, by means of little sketches or "models" similar to those used in the present article, how the chemist makes higher and higher octane gasolines. In the present article he explains by means of similar models why rubber is elastic, and why the rubber chemist's modern knowledge of the secrets of manipulating moleclues enables him to design and make synthetic elastomers (rubber-like substances including rubber). The little drawings are not, of course, offered as precise representations of atoms and molecules, especially as the precise nature of these entities remains in part unknown. Science does know that atoms are not neat little circles or balls with little fishhooks attached, but it also knows enough about their arrangement to be sure that such conventional models represent their approximate nature. At least, as practical representations these structural formulas serve our purpose in explanation and in every-day use.**

Professor French is the author of the recently published books, "Torch and Crucible" and "The Drama of Chemistry," chosen from many popular chemistries to run serially in The Dow Diamond, the magazine of the Dow Chemical Company—the first issue of which appeared in January.—The Editors. ■

SEVEN hundred thousand tons of synthetic rubber by the end of 1943 —to be produced in American factories as yet unbuilt! The world has never before had ring-side seats at such a stupendous undertaking in the translation of science into stark necessities.

Can it be done? Had that question been asked before December 7, 1941, the answer no doubt would have been an assured and cocky, "Yes, if we were put to it!"

Today we are put to it in no unmistakable manner. What is the answer now? There is less cockiness, more seriousness, as there always is when a boast must be turned into a result. But the answer is still, "Yes!" Either we produce synthetic rubber or we go down to defeat. Planes and tanks must have rubber—an amazing amount of it. So must soldiers, cannons, and battleships. In such a diversity of items as raincoats, boots, tires, pads, gas masks, surgical gloves, hose, de-icers, gas tanks, insulation, storage batteries, and on up to 2000 or more items, rubber plays its essential part in war.

Had we faced today's crisis a decade ago, we would have been helpless; we did not know how to make satisfactory synthetic rubber. Today, we do know how; not only do we know how but we are already producing it in modest amounts—not one kind but more than two dozen types of this strategic material.

East Indian natural rubber is out for the duration—possibly forever. It provided 97 percent of our rubber products. Talk of developing the Mexican guayule shrub or any other[1] rubber-yielding plant in time to meet our urgent needs is wasted breath. For the long view such investigations may be worth while but not for tomorrow's view.

It can, of course, be argued that the proposed gargantuan expansion in synthetic rubber is equivalent to pouring money down the neck of an industry due to choke of its own weight after the war when it must face the competition of natural rubber. Perhaps so, but it is costing us only the price of a couple of dreadnoughts, even were we to lose all of it. We expect to lose battleships, and we must be prepared to lose our investment in synthetic rubber. That we shall lose it, however, is far from certain; such mass production is bound to lower the price of synthetic rubber to a point where it may be able to meet the price set on its natural rival even in peace time. Furthermore, some of the synthetic varieties possess properties not found in natural rubber, and will supplement rather than displace the natural material.

During the 1930's, Herr Hitler boasted at least three times that his scientists knew how to make synthetic rubber. Of course, he was 50 years behind the times, since the first synthetic rubber had been prepared — more or less by accident—in 1884. He had even forgotten that the Kaiser's scientists had developed a synthetic rubber—not one to boast much about, however—during World War I. Finally, he conveniently overlooked the fact that the first successful commercial synthetic rubber was developed in the United States and appeared on the market in 1931.

THIS product was neoprene, the brain-child of a modest but brilliant scientist-priest, Father Julius A. Nieuwland[2] of Notre Dame University, and the equally brilliant Wallace Carothers and his associates from the Du Pont Chemical Company. Together they wrote the pages of a fascinating story which translated the findings of theoretical science into the production of thousands of tons of neoprene. Without doubt, before the manuscript for the present article is finished, many of its superflous words will have been erased—with a neoprene eraser. Without doubt this eraser will have to last for several years. Fortunately, it will; because neoprene does not age like natural rubber. That is one of its important and useful qualities.

Today, 11 years after neoprene hit the market, it is still important and growing but it no longer holds the stage alone; it has some 28 competitors and associates to spur and comfort it. Not all of these 29 varieties will prosper but many of them will. Some are so new that we know little about them as yet. In the year 1940 alone, six new American varieties of synthetic rubber were introduced to the public.

With this great array of new elastic materials and new names to bewilder us, the scientists have decided that they must scrap the all-inclusive term of synthetic rubber. These materials are *not* rubber, but rubber-like. To be in the van, we must now call anything whose nature is elastic an *elastomer*, whether it comes from the rubber tree or the test tube. Hence, we have natural and synthetic elastomers.

The all-important question is, how are these synthetic elastomers made? But before attempting to answer this, we had best find out how nature's elastomer is made. This is the path of all science—and of most any other

[1] A systematic survey of these plants—the Madagascar rubber vines, milkweeds, Russian dandelion, goldenrod, rabbit brush, and osage orange—prepared by the United States Department of Agriculture, appeared in Scientific American last month, pages 276-277. This survey concurred with the above-stated opinion of the author: reliance on any of these emergency plants is wishful thinking.—Ed.

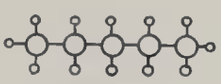
[2] A two-page article on neoprene, by Father Nieuwland, appeared in the November, 1935, number of Scientific American.—Ed.

endeavor, for that matter. First, we study existing models, tear them apart, analyze the construction; then we attempt to build as the model is built; finally, we branch out, modify and change the model more nearly to suit our needs.

The scientist has known since 1860 what kind of units rubber is built of. The trouble was that he knew neither how to make these units nor how to fasten them together. It has taken him three score years and ten, the lifetime of a man, to learn these tricks which, now that we comprehend them, seem rather simple.

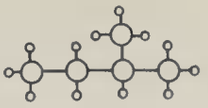
Natural rubber, and most synthetic elastomers, are substances known to the chemist as hydrocarbons. Translated, this means that a rubber band is composed of billions upon billions of tiny, invisible carbon atoms, plus more billions of hydrogen atoms. Yet, for that matter, gasoline, kerosene, mothballs, benzene, and a host of other substances are also hydrocarbons. So the secret of rubber lies not in the mere fact that it is a hydrocarbon. Rather it lies in the manner in which these carbon and hydrogen atoms are hooked together—in the architecture, in the pattern.

WHAT is this pattern so essential to rubber? It is a simple one, fortunately, yet it is as full of potential surprises as a treasure chest. The chemist knows full well the unique habits of carbon atoms. They tend to string along like cranberries in a Christmas chain—and each carbon atom is decorated with smaller hydrogen atoms, like glass-headed pins stuck in to add to the gaiety. There is one sacred rule which no chemist dares disobey. In his model, each carbon atom must, somehow, have four attachments, and these must be distributed between its neighbors in the chain and its attending hydrogen atoms. Thus, we can build our cranberry-pin model of a hydrocarbon as follows:

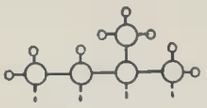


This fellow, called pentane, happens to have five carbon atoms in the chain, but the number five is not sacred; we might have more, or less.

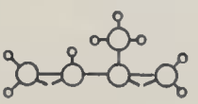
As long as we preserve our sacred rule of four attachments, we can do most anything we wish with this molecule—on paper at least. For example, we might pull a berry off one end and place it on the side of the chain, the berry trading places with a hydrogen "pin," thus:



Now let us behead the four bottom pins, thus:



We have disobeyed the sacred rule! We have left one attachment, or bond, on each berry, waving in the air, tied to nothing. This cannot be. Compromise is a rule of molecules as well as of life, so the waving bonds, finding nothing better to do, tie up with one another in the following pattern:

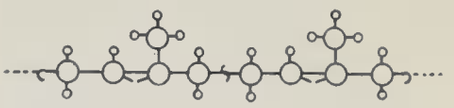


Fortunately, for the existence of rubber, these extra bonds are quite unhappy and superfluous. They are the stags at a dance, ready to flit away in search of a better partner, tolerating their union as a makeshift arrangement only.

THIS lop-sided molecule with its extra stags is a very famous one. It is isoprene, the "rubber brick," the unit of which all natural rubber is composed. The chemist prefers to call it by its generic name of methylbutadiene. And, contrary to popular belief, such a name is not mere gibberish; it gives to the chemist an exact picture of the molecule and its parts. The confusing thing is that he writes it without hyphens, as though he were to write, "the-house-by-the-side-of-the-road" as "thehousebythesideoftheroad." Methyl means a carbon atom with three attached hydrogens. Buta means a four-carbon atom string. Di means two. Ene means stags or, more technically, double attachments. Thus, we have a methyl group tied to a buta chain containing two double attachments.

When we have molecules of methylbutadiene, we by no means have rubber, any more than we have a Paul Jones dance when we have an assortment of people all with hands in pockets. We must get these molecules to join hands, and this, of course, is where the stags enter the picture. Without them, there would be no hands to join—and no rubber. But before this joining of hands can take place, there must be proper introduction. Finding the proper introducer is no small task. It has been, and still is, one of the most difficult jobs of the budding synthetic elastomer industry.

Once this important personage has been found, the rest is easy; each methylbutadiene molecule links up with a neighbor, end to end, as is illustrated, the necessary stags swinging around to meet those from each neighboring molecule:



When billions upon billions of these molecules become linked in this manner, we have a rubber fiber. But notice what has happened. Not all the stags could participate in this Paul Jones affair. Two stags in each molecule are still left disconsolate. They pair off in the middle of each "brick." Perhaps we can provide suitable partners for them yet.

JUST why should this linking of molecule to molecule in such a manner give a substance which can be stretched to several dozen times its original length and rebound once more when released? With all the exhaustive work they have done on rubber in a century, the chemist and the physicist together are still unable to give a complete answer to this question. But they have several very good theories. They know, for example, that long molecules built up in this way are not straight, but coiled like a spring. But this is true of any long carbon chain molecule, yet not many of these have the stretch of rubber. We must look elsewhere for the complete answer.

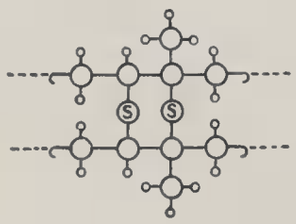
The X-ray has shed light on many a scientific problem; it sheds surprising light on the structure of rubber. When X-ray photographs are taken of crystals, the positions of the very atoms themselves are exposed and these positions reveal a perfect regularity of pattern. In a liquid, on the other hand, we get only a smear, indicating that the molecules are gloriously and irregularly mixed. Under the X-ray, relaxed rubber behaves like a liquid, stretched rubber like a crystal. Is relaxed rubber, then, a liquid? Well, the scientist is inclined so to regard it. The atoms are so gloriously mixed that they do not know to which molecule they belong. For this state of affairs we can no doubt thank the remaining stags. In their search for partners, they reach out to take hold of atoms further up the chain, out of line, so to speak. In doing so, they cause the long string to fold back on itself somewhat like a folding ruler.

We might picture it thus, showing only the spiralled carbon chains and the stags (in dotted lines) holding the folds loosely together:

When the rubber fiber is pulled, the stags give, like tiny springs, the molecules are literally stretched into shape and the X-ray reveals a crystal pattern. Actually, the scientist believes that the rubber units sort of fold into, and dissolve in, one another when the rubber is relaxed.

IN THE year 1844, United States patent number 3633 was issued to Charles Goodyear on the vulcanization of rubber with sulfur. This is the patent which brought about at one and the same time the most famous lawsuit of the century and the great rubber boom. Pitted against the oratory of Rufus Choate, Daniel Webster won the suit for Goodyear. But, regardless of who won the suit, the case for rubber has been thoroughly established. Without sulfur, rubber is soft, pliable, and has little tensile strength. When sulfur is added, we obtain products ranging in stretch and hardness from the rubber band to the hard rubber insulator. Why this amazing shift and range of qualities upon mere heating with sulfur?

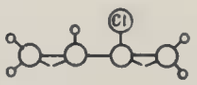
Perhaps you have guessed it. The stags once more! These remaining stags are delighted to join hands with sulfur atoms, each sulfur atom — S within a circle — taking on two stags as shown:



Thus, we have several fibers of rubber joined together — braced, as it were, by sulfur atoms. Each fiber lends its strength to the other. No wonder the tensile strength goes up. But the stretch goes down, because the stags are no longer available to tie fold to fold. If we put in just enough sulfur to use up every second stag, we can still have some fold and stretch left, but if we put in enough to use up all the stags, stretch is gone and we have brittle, hard rubber. It is little wonder, then, that we can get almost any combination of stretch and hardness by varying the sulfur content. There are, of course, many other substances, such as zinc oxide and carbon black, which play important roles as fillers and hardeners in rubber.

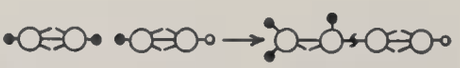
Little enough has yet been said about synthetic elastomers but, in reality, little need be said about them. The principles, with a few modifications, which apply to rubber also apply to synthetic elastomers. Once we knew what kind of molecules composed rubber, and how they were linked together, we could go about building synthetic materials along somewhat similar lines.

Neoprene is composed of units of chlorbutadiene — you have guessed it: a molecule of neoprene differs from natural rubber only in having a chlorine atom (Cl within a circle) in place of a methyl group, thus:

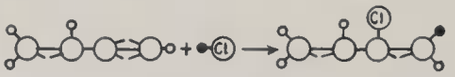


It is as though we had placed a cherry on a cranberry chain. This chlorine atom gives to neoprene several surprising characteristics. The stags are now so active that no introducer is necessary to unite the molecules into chains; they do it of their own accord. The remaining stags then cross-tie the strings into strong bundles of fibers. Vulcanization is unnecessary and, in fact, impossible in neoprene.

THE source materials for neoprene are abundant and cheap. Acetylene molecules join hands to form vinylacetylene:



(Notice how some of the hydrogen atoms — those shown in black — have shifted to effect this union.) Vinylacetylene then reacts with hydrogen chloride to form chlorbutadiene:

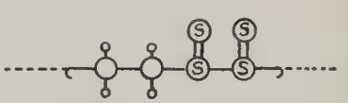


(Notice how the stags have been reduced in number by these processes.) The chlorine comes from salt. The cost is in the manipulation, not the materials.

The German synthetic elastomers about which Hitler boasted so loudly are known as Buna S and Buna N. Both are made from butadiene, but not from it alone. Interspersed with the butadiene molecules in Buna S are styrene molecules, somewhat complicated, but possessing the ever necessary stags. To introduce styrene to butadiene, the metal, sodium, is used. The chemist's symbol for sodium being Na, you have the origin of the name Buna S — Bu- for buta chains, na for the sodium introducer, S for styrene. In Buna N, acrylonitrile (N) takes the place of styrene.

Before succeeding in making these alphabet bunas, Hitler's scientists had succeeded in making plain bunas (butadiene molecules strung together). These early perbunans—note the derivation of the name—were almost as bad as the Kaiser's cumbersome elastomer in World War I. But the alphabet bunas are of high quality. They can be vulcanized, have high tensile strength and resistance to wear. The raw materials come from petroleum buta- chains — often previously wasted — resulting from the manufacture of gasoline. With our vast resources of petroleum, it is little wonder that we stand ready to lead the world in making all types of buna elastomers. And it is for these products largely that our great government-endowed expansion program is planned. Already the American public has met three such brands: Ameripol, Hycar, and Chemigum. It will meet many more in the near future.

NOW that we have learned how to make stagged molecules and to hook them together, we are no longer limited even to hydrocarbon chains. Thiokol (thio means sulfur) elastomers have sulfur atoms right in the chain. Here is a model unit of a thiokol elastomer



made from acetylene and sulfur. There are at least three commercial varieties of thiokol on the market.

Then, there are elastomers which are neither entirely fish nor fowl. They are hybrids of elastomers and plastics. They lack the stretch but have the great flexibility and water proof qualities necessary to make them useful in hundreds of ways. Such a product is Koroseal, made from acetylene with chlorine as the introducer.

Finally, another group stemming from petroleum, the butyl elastomers, is fast coming upon the scene. As yet, we know little about these products but they show great promise.

Delighting in high-sounding names — which, nonetheless convey real meaning to him — the chemist dubs these endless molecules, made by the

joining of hands of numberless small identical unit molecules, polymers. If the small molecules are not identical, the product becomes a copolymer. The process is polymerization or copolymerization.

The great significance of polymerization is not so much that we have at last learned how to make these synthetic elastomers, important as that may be in these grave days; it is that we have mastered the secrets of making these stagged molecules, of finding the proper introducers, of building endless molecules to *our own specifications.* We have just made a start, and at present we are still trying largely to imitate the qualities of natural rubber.

But there is no apparent limit to the diversity of products which we may obtain through copolymerization. We may go on building these experimental endless molecules till we find some that far surpass natural rubber in elasticity, some that surpass it in wearing quality, some that surpass it in weathering quality, and in resistance to tear. So we shall have, eventually, not a single imitation of nature's product but thousands of new useful products, each with its own valuable qualities, adapted to its own particular uses.

Nor will we stop with these diversified rubber-like materials. After all, elastomers and plastics belong to the same great family of polymers and copolymers. We shall go on mixing the breeds till we have produced elasto-plastomers and plasto-elastomers almost without end and with every conceivable gamut of qualities.

And for our starting materials all we need are limestone, coke, water, sulfur, chlorine, and petroleum. There is no shortage of these in America!

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BEST WAVELENGTH

For Short-Wave Communication Can Now be Predicted

AUTOMATIC recordings of electrical conditions in the upper atmosphere now make it possible to predict with accuracy the best frequency to use for short-wave communication at any given time. The automatic multi-frequency recorder used for this work is a development of an "echo" technique for investigating the ionosphere, the radio-reflecting layers of the upper atmosphere whose heights affect short-wave radio.

Personalities in Science

SIR C. V. RAMAN

AT TRICHINOPOLY, in Southern India, Chandrasekhara Venkata Raman was born on November 7, 1888. He received his early education at the Hindu College, Vizagapatam, where his father was a Professor of Mathematics and Physics. Later, he studied for four years at the Presidency College, Madras. He graduated from this institution at the age of 16, and two years later took his master's degree, in both cases with the highest distinctions. Even as an undergraduate at the Presidency College young Raman displayed his genius for original research and independently carried out his first investigations in optics and acoustics. His capacity for scientific research greatly impressed academic circles at Calcutta and led to his being invited by the University of Calcutta to accept a newly endowed chair of Physics. In April 1933, Raman left the Calcutta University and accepted a call from the Indian Institute of Science at Bangalore, where he now works.

The research papers published in the last 20 years by Raman, and collaborators in his laboratory, include over 600 titles and concern themselves with a variety of subjects such as the dynamics of vibrations and sound, the theory of musical instruments, diffraction problems, meteorological and colloid optics, X-ray diffraction in liquids and solids, magnetism and magneto-crystallic action, electro- and magneto-optics, photo-elasticity of solids and fluids, dielectric behavior, and ultrasonics. By far the best-known work of Raman is his discovery early in 1928 of the new radiation effect known by his name and which was the natural culmination of the investigations on the scattering of light, systematically conducted in his laboratory since 1921. The 14 years that have elapsed since the discovery of the Raman effect have witnessed the fulfillment of the confidently expressed hope of the discoverer that it would throw new light on many problems in physics and chemistry. Several thousand papers have now appeared on this subject, but the possibilities of further advances in both physical and chemical applications are far from being exhausted.

Impressive though his own personal contributions to science have been, Raman's greatest achievement in his leadership in the renaissance of science that has been taking place in India during the past quarter of a century. The progressive enthusiasm for scientific studies and research that exists in India today has largely been inspired by him and encouraged and sustained by his efforts. His personal example of self-dedication to a scientific career, the brilliance and originality of his researches, the international recognition that his work has received, his gift for eloquence which has served to stimulate a widespread interest in science, his achievements as a scientific administrator in creating facilities for research and establishing new schools of science, and his success in founding journals for publication of scientific work in India are among the factors which have profoundly influenced the progress of science in that country.

The world was not slow to recognize the importance of Raman's achievement as an investigator and a leader of scientific research. Scarcely had he completed six years as a Professor of Physics when the Royal Society of London elected him a Fellow in 1924. He was knighted by the British Government in 1929. He was the recipient of the Matteucci Medal of the Italian Society of Sciences in 1928, of the Hughes Medal of the Royal Society in 1930, and in the same year he was awarded the Nobel Prize for Physics.—*Dr. W. F. Meggers, National Bureau of Standards, in the* Journal of the Optical Society of America.

A Pier in Time —

Psychology Joins With Engineering Skill to Produce a "Hospital" Pier in Record Time of 43 Days

A. D. RATHBONE, IV

DRIVING creosoted piling into the chill waters off the rim of Staten Island, in New York harbor, during late February and early March, is no job for a sissy. But there weren't any sissies in the 120-man pier-building crew of the George W. Rogers Construction Company. Mostly husky, raw-boned, taciturn Scandinavians and Finns—men to whom the words Oslo, Stockholm, Köbenhavn, Helsinki meant members of families still in Nazi-occupied, influenced, or threatened countries—this gang of burly workmen spoke little, drove hard, and completed a 700-foot utility pier for the United States Navy in the record time of 43 days as part of their contribution to beat the Axis Powers.

Prosaically known as Pier 10, this engineering job forms the final factor of a three-part unit comprising a ship-launching way flanked by fitting-out piers, Numbers 10 and 11, in the Bethlehem Steel Company's yards, and is unique not only for the necessary precision maintained during the speedy building of the unit, but also for the somewhat novel method of construction. The shipway, designed by Lockwood Green Engineers, Inc., has an unusually heavy concrete deck carried directly on the heads of the piles, which extend six inches up into the slab.

As it was considered undesirable to break the creosoted skin of the piles by nailing stay-laths to them, a hanger system was devised by using Richmond tie hangers carried on sections of light rails, which in turn rested on the heads of the pilings. On this suspended framework the criss-crossed reinforcing steel rods were laid and hand wired at approximately a million separate crossing points. The forms were then constructed and, with the above method of suspension, proved to be satisfactorily stiff and solid. "High-early" strength, pre-mixed concrete was poured, at some points under pneumatic pressure, and such was the speed on the job that, with the quick-setting cement, trucks could be and were driven over the deck 24 hours after pouring. The deck on this shipway varied from 12 to 25 inches in thickness, being generally 12 inches at the sides and 24 inches under the keel blocks.

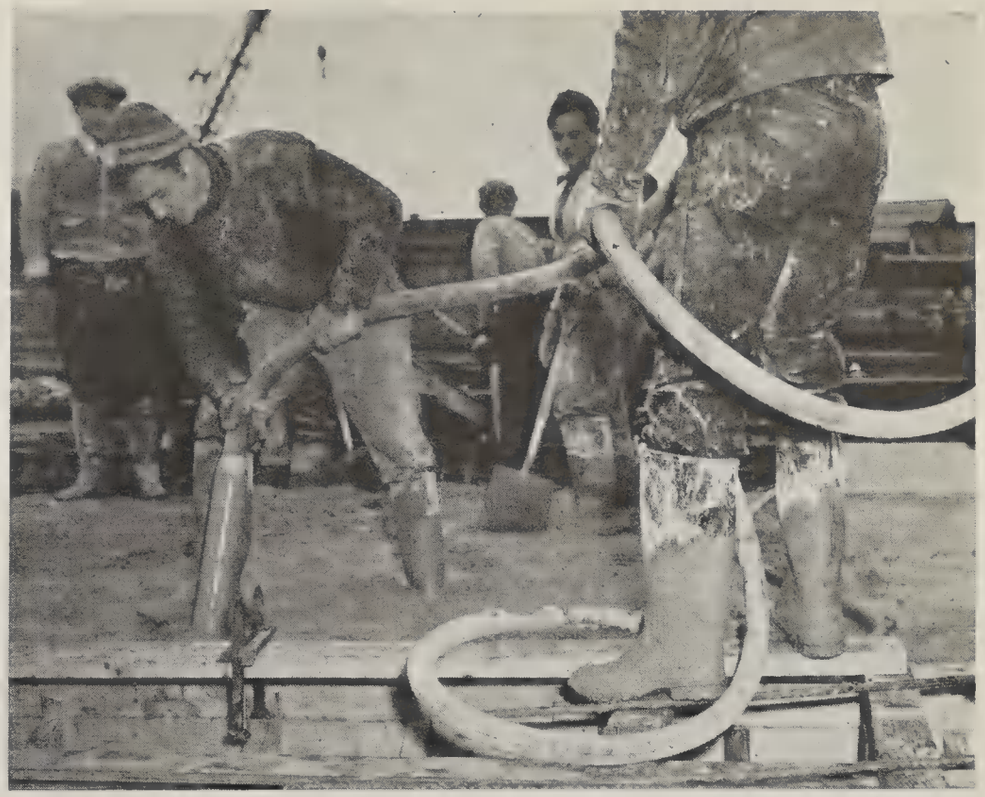
The piles for Pier 11, which was constructed first, 72,500 linear feet of them—about 13.5 miles—were driven by floating pile drivers equipped with 75-foot leads and Vulcan Number 1 steam hammers. It was necessary to force the pilings through some 12 feet of mud, then to penetrate 12 to 14 feet of hard material — clay, sand, and gravel—before reaching the underlying strata of rock. The nicety and accuracy of the job can be realized when it is known that the piles were shaved to a specified level and the general surface line-up graded by surveyors.

In the middle section of the launching way, after the piles had been driven and batter piles placed both ways longitudinally, riprap was placed in an area 60 feet square to resist the thrust during launching. The outer end of the way was built of creosoted wood for a distance of 84 feet. This wooden apron extends from about half-tide to a point two feet below low water, and here the construction work was accomplished largely by employment of a crew of divers.

More than a million wired joints, each twisted with special anti-Axis gusto, went into preparation of framework

A crew of Scandinavians and Finns, moved to extra efforts by thoughts of home-folk in occupied countries, rushed construction of "700 Feet Toward Victory"

Although the shipway and one of its flanking piers were completed sufficiently ahead of schedule to permit laying the keel of a ship nearly four weeks earlier than planned, all that happened last year, before Pearl Harbor. Then the Bethlehem Steel Company and the Navy informed George W. Rogers, President of the firm that bears his name, that his original estimate of 90 days for completion of Pier 10, the final unit in this group, would have to be cut to 45 days. Inasmuch as this was a lump-sum contract and not on a cost-plus basis, the speed-up proposal, however much it might mean in our shipbuilding program, was something for any contractor to conjure with.

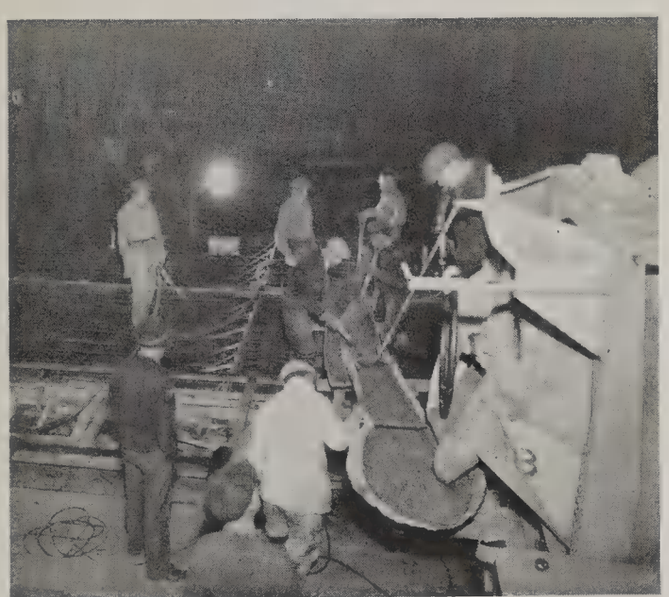


Such was the speed-up on the Pier 10 job that at one time cement was being poured at shore end of the pier while piles were being driven at outer end

However, Rogers, whose grandfather began building piers for the government in 1869, and whose father continued the family construction tradition during World War I, has been doing things with men, and steel, and concrete since he, himself, finished his trick in the Navy in 1919, and he said he believed it could be done.

There were, inevitably, some temporary shortages of material, although everything possible was done to prevent hold-ups, even to trucking special loads of piles from as far away as Wilmington, Delaware. "At one time," reminisced Mr. Rogers, "we were pouring cement at the inshore end—which was then virtually completed—while we were still driving piles at the outer end—a crazy method to run a pier job, but there just wasn't any other way."

Despite a scarcity of skilled dock builders, the 700-foot-long Pier 10, composed of 42,700 linear feet of creosoted piling, 200,000 board feet of creosoted timber, and 22,700 square feet of concrete, was completed in the unprecedented time of six weeks and one day. The work was done on a two-shift, seven-days-a-week basis, and although flood-lights shone over the cold, black waters to help the night shift, all driving of piles was done in the daylight for the sake of safety. Before the concrete of the deck was poured, huge H-beams were placed horizontally at their specified points, with no deviations allowed. The rails on which the 100-foot-high cranes move back and forth astraddle of the ship, lifting and placing armor plate, turrets, or heavy guns, were laid over the H-beams. At the dedication ceremonies both cranes were on their rails.



Night and day, many tons of "high-early" strength premixed concrete flowed into forms in a steady stream

One of the cranes has a capacity of 15 tons and the other can handle 20 tons. A unit of two outfitting piers, such as numbers 10 and 11, and the shipway they flank, has aptly been referred to as "hospital piers," for here all manner of shipbuilding operations may take place. They may be used to graft machine guns, cannon, additional armor plate protection to a merchant vessel in the course of its conversion to some type of warship. Newly launched hulls may receive what it takes to make a fighting ship strong and powerful. "When a ship's battered," says Rogers, "it needs a hospital. When you have guns, tanks, planes, you need ships to take them places. No piers—no ships."

To commemorate the completion of this Navy utility pier in the record time of 43 days, 25 days less than the previous record, a bronze plaque was sunk into the newly poured last yard of concrete deck, and the entire job has been looked upon as something of a barometer of wartime co-operation and effort.

Realizing today's urgency for this type of construction in our shipyards and knowing his Scandinavians and Finns for what they were, Rogers combined psychology with engineering knowledge. He mingled freely with them at all hours of the day and night, asked them what they heard from their folks in Norway, Sweden, Denmark, Finland. It worked! Tight-lipped, they replied little, but seemed to delight in venting pent-up emotions on the huge timbers and steel beams, on the tangled reinforcing rods and ever-flowing concrete. They hung up a sign designating Pier 10 as "700 Feet Toward Victory," and with this brand of co-operation and the simultaneous co-ordination of suppliers of materials, Rogers' promise to the Navy and to Bethlehem Steel Company was fulfilled.

RW Tauri

A Remarkable Eclipsing Variable Star with a Gaseous Ring Whirling About One Component

HENRY NORRIS RUSSELL, Ph.D.
Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

AN UNUSUALLY interesting piece of news (now published in a technical journal, and hence available for these columns) comes from Dr. Joy at Mount Wilson. For years this veteran observer has been following eclipsing variables with the spectrograph, and measuring their radial velocities. This is scientifically remunerative, for if the orbital motions of both stars of a pair can be recorded, the real dimensions of their orbits, and the actual sizes, masses, and densities of the two stars can be calculated. But it is also very laborious, for the bright stars of this interesting type have long ago been worked up, and the faint ones demand long exposures.

In some of the most interesting systems, the star of larger diameter is fainter than the other, and the eclipse is total. By observing while the small bright star is completely hidden, we may then study the spectrum and motion of the larger without disturbance by the light of its much brighter companion — which, when both are visible, drowns the other out completely.

To work up such a problem demands great patience, for the total eclipses last at most a few hours, while the intervals between them are measured in days. For a large percentage of the eclipses, the star will be below the horizon, or too near it to be observable. More than half of the rest will come in the daytime, or twilight. On the average, fully three quarters of the eclipses will be unobservable for these reasons.

In a great observatory, where the time of the telescope must be divided among many astronomers, a considerable part of the possible chances will come on nights when the instrument is equipped for some quite different type of work, or when the moon is "wrong." This cryptic remark means that some types of observation—such as direct photography of faint nebulae—can be done only on clear, dark nights. Moonlight, which drowns nebulae out altogether, does not bother the spectroscopist, since little or no moonlight gets through the narrow slit of his spectroscope, upon which he keeps the star-image centered. The dark of the moon is therefore sacred to the nebular program, and certain others, while spectra are photographed when the moon is bright. Two spectroscopic observers may, and frequently do, exchange nights when one of them has something of exceptional interest, but a general indiscriminate exchange of working hours is impracticable.

When the long-awaited eclipse comes at last on an available night, it may be cloudy — even in the best of climates — or, though the stars are visible, the irregular refraction in our atmosphere, known as "bad seeing," may enlarge the image of a star so much that only a small fraction of its light gets through the slit of the spectroscope.

FOR an ordinary star, this necessitates a much longer exposure — which diminishes the total amount of the night's work, but not the value of each plate. But, when the eclipse is short, and the star faint while it lasts, the lengthened exposure may run over the time allotted by nature. The observer, realizing that he can get only a blend of total and partial eclipse, which he does not want, will regretfully turn to some other star on his list, and hope for better luck next time.

RW Tauri—the star here discussed —is peculiarly laborious to observe. Normally of magnitude 8.1, it drops to magnitude 11.5 at intervals of $2^d\ 18^h\ 45^m$. The fainter component obscures the brighter one completely for only an hour and 20 minutes—less than one fiftieth of the period—so that the chance of finding it faint at a random glance is very small, and the observer who wishes to study it at minimum, though provided with accurate predictions of its occurrence, must waste no time. During the total eclipse, the photographic brightness is nearly half a magnitude fainter than the visual, showing that the companion is reddish. At this time, when the glare of the bright star was cut off, Joy discovered a visual companion of magnitude 12.5, at an apparent distance of 1″ from the variable. Small as this seems, it must be several thousand times the distance which separates the eclipsing pair, and it will be many years before it can be determined whether this companion is really related to the variable, or merely in line with it, but much nearer or farther away.

ALLOWING for the light of the third star, it is found that the larger component of the close pair emits but 1/36 as much light as the star which it eclipses. Only one or two cases of greater disparity in brightness are known. To get a spectrum of a 12th magnitude star showing good detail in so short a time demands very powerful equipment. Only the 100-inch reflector is really equal to the task; but with this Dr. Joy has secured several spectra during totality on different nights, some with exposures as short as 45 minutes.

These plates show a spectrum of Class KO, (similar to that of Arcturus) with well defined lines, while those taken outside eclipse show an equally well defined spectrum of Class B9 (corresponding to a star a little hotter than Vega) belonging to the brighter star, which drowns out its fainter companion completely. The great difference in temperature between the two stars accounts for the difference in brightness.

Many other totally eclipsing pairs are known, in which the difference in brightness, though large, is less than for RW Tauri. The distinctive peculiarity of the system is that, at the time of total eclipse, remarkable bright lines appear in the spectrum. These were observed by Wyse at the Lick Observatory in 1933, but not followed up until Joy's recent work.

A spectrogram taken in 1940, with an exposure of 65 minutes, covering almost the whole duration of the minimum, showed that the hydrogen lines, Hβ, Hγ, and Hδ, were bright and widely double. The two components of each line were shifted equally far to the red and to the violet of the normal positions, by amounts corresponding to velocities of 350 kilometers per second in each direction. Fainter emission lines of ionized magnesium, calcium, and iron were also observed on this and later plates.

This enormously wide doubling of

the emission lines cried aloud for explanation; and this was forthcoming when observations during the total eclipse were made during 1941.

These show that if the exposure was commenced as soon as the eclipse became total, and stopped at or near its middle, only one of the two emission components was visible for each line, namely, the one on the side toward the red. For an exposure beginning at mid-eclipse, and continued till close to its end, only the bright lines on the violet side of the normal position appeared; and, upon a plate taken during the middle of the eclipse, there were no bright lines at all. The first plate, with its longer exposure, was evidently a composite photograph, combining effects observed at different times into something that could not have been seen at any one time.

THESE apparent complications may be interpreted as illustrated in Figure 1 (which is drawn approximately to scale). Let B represent the brighter star, and F the fainter companion. The Earth is supposed to be in the plane of the page, at a great distance below. F may be drawn as revolving around B in a circular orbit O. (In fact, both B and F describe orbits about their common center of gravity, keeping on opposite sides of it; but to put this into the diagram would complicate it needlessly.) As F moves along this orbit, it will hide more and more of B, till, finally, when its center reaches the point F_1, the eclipse will become total, and continue so till its center is at F_2.

Now suppose that B is surrounded by a gaseous ring of very low density (containing hydrogen and small quantities of metals, and emitting bright lines) which is rotating rapidly about it in the same direction as the orbital motion of F. After the total eclipse of the luminous body B has begun, the part of the ring at R_1 will still be visible. It is receding from the Earth, and the bright lines which it emits will be shifted toward the red. Toward the end of totality R_1 will be hidden by F, while the opposite side of the ring at R_2 will be visible, and give bright lines shifted toward the violet. Since both bright components disappear for about 30 minutes at mid-eclipse, the outer diameter of R must be considerably smaller than that of F.

This explanation is as simple geometrically as it is convincing. The question remains how this gaseous envelope can exist permanently in such rapid motion. It is not carried around by the rotation of the star below it, for the lines in the spectrum of this star are fairly sharp, and show that its own rotation, though doubtless in the same direction, must be much slower.

It seems probable that the gases of the ring are in orbital motion about star B—held up by the centrifugal force of their own motion, just as a solid satellite would be, and high enough above the star's surface to avoid friction with its atmosphere. Rough calculations show that an

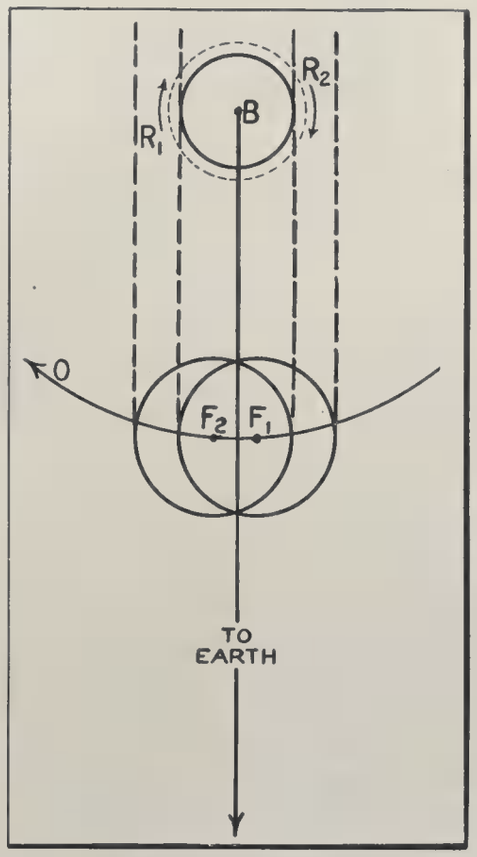


Figure 1: See the text

orbital velocity of 350 kilometers per second should be expected in this region if the mass of the bright star was about 1½ times the Sun's, and that of the fainter ones about one third as great. These are plausible enough values—though rather smaller than one might expect.

When enough observations of this remarkable star have been secured, the masses of the components may be found, and the equilibrium of the ring studied more fully.

How such a mass of gas "got that way" is a problem which is best left alone till we know more about the details than we do now.

Whether other stars have similar rings revolving about them is unknown. The possibility of such a thing was suggested by Struve, some years ago, from consideration of certain stars with peculiar emission lines, bright enough to be observable though the star itself is unobscured. The present ring, however, is so faint that it would hardly be observable if the eclipsing companion were not unusually faint, and it may be hard to detect other cases.

It is remarkable that two stars of such different brightness should be so close to one another. A large number of similar cases—though less extreme—are found in the lists of eclipsing variables. Indeed, such pairs have been called "typical Algol systems."

It is practically certain, however, that such systems are not typical of the short-period double stars in general—such as are detected in great numbers as spectroscopic binaries. There is no more striking example of the power of observational selection—forced upon us, independent of our intentions, by the very nature of the case.

THE great majority of variable stars have been discovered by comparing photographs of the same region taken at different times. In such a search, large variations in brightness are practically sure to be picked up, while smaller ones may be missed. Under what circumstances can a large variation—reducing the normal brightness to one sixth or less—be produced by an eclipse? At the middle of eclipse we see the light of the star which is in front of the other, and often an uneclipsed part of the light of the other. Hence, to meet the condition just imposed, the eclipsing star cannot have more than one sixth of the total light of the pair, or one fifth that of its companion. Deep eclipses can come only from pairs of unequal brightness. Even among these they cannot happen if the fainter star is much smaller in size than the other; for then, if it is squarely in front of its neighbor, it will cut off only a moderate fraction of its light. When the fainter component is the larger, it may completely obscure the light of its companion, and there is no geometrical limit to the depth of the eclipse. The fact that no eclipses of a depth as great as five magnitudes have yet been observed indicates that cases in which the larger star has as little as 1 percent of the brightness of the smaller ones must indeed be exceedingly rare.

The large, faint components of these pairs are "sub-giants"—brighter than normal main-sequence stars of the same temperature, but fainter than ordinary red giants. Their masses, when known, are smaller than those of ordinary stars of the same luminosity. Their constitution presents an interesting theoretical problem which has not yet been solved.

—Princeton University Observatory, April 29, 1942.

A Maya Temple Grows Up

Archeologists in Guatemala Reveal the Evidences of a Five-Times-Reconstructed Temple

LINTON SATTERTHWAITE, JR.
Assistant Curator, American Section,
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MODERN archeology is the business of digging into ruins and rubbish piles of forgotten peoples. Any archeologist will tell you he is trying to reconstruct the history of the people concerned. Some will claim that they are helping to discover laws governing the rise and decline of human societies. I believe this may be so, but that scientific curiosity is the immediate force which drives diggers to plan and sweat, and institutions and public-minded citizens to foot the very considerable bills. You, yourself, are reading this article because you are curious to know about the illustrations that accompany it.

These illustrations — the drawings on the opposite page — are reconstructions on paper of a single Maya temple and the various alterations to which it was submitted. It was part of a religious center or "city," now called Piedras Negras, in the semi-tropical forested part of Guatemala, Central America. Its ruins cover a square mile and have been extensively excavated by the University Museum of the University of Pennsylvania. I had charge of several seasons of work on the city, work which was begun by Dr. J. Alden Mason, Curator. Investigating this particular structure was part of my task, and I was assisted by William S. Godfrey, Jr., who made the drawings.

There are five isometric perspective drawings, showing how the temple was changed from time to time. The photographs will give an impression of the size. The upper left-hand drawing of the five shows it at the start. Later, the Maya had cut down the walls of the building to doorway height, as shown. The same thing was done by Godfrey on paper in the case of the fourth drawing, so that the reader can see into the room. The separate drawing shows the same building, after some changes, but with the roof in place.

As drawing succeeds drawing, the date of the new construction shown is later and later, yet each drawing is of essentially the same thing. There was a temple building at the top; this cannot be shown in the second and third drawings because little or nothing was left of it. The building rests on a low platform, and this stands on another with a stairway, except at the time of the second drawing. Below this is a platform of either two or four terraces, with its own stairway, and this is on a terrace with yet another stairway. These platforms form an example of what have been called "Maya pyramids." They are made of solid rubble — that is, shapeless, broken rocks — which was laid up in rectangular sections. The rough platform thus built was then given a skin of plastered stone masonry. The stones in the outer walls forming this skin were laid in mortar. This is limestone country, and limestone was burned to get lime for the mortar and plaster, and, toward the end, for ornamental stucco-work. In the photographs, the plaster has peeled off.

The purpose of these bulky platforms was to elevate the temple building and the little round stone altars in it and before it. The structure provided an awe-inspiring setting for elaborate religious processions, sacrifices, and ceremonies.

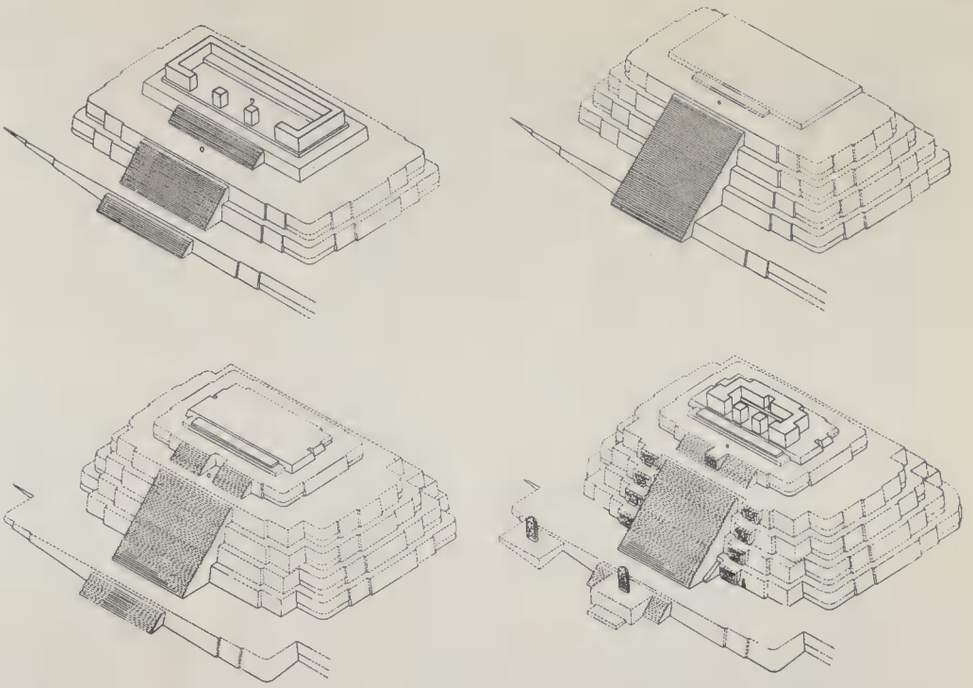
The time-span of the five varieties of the temple is probably four or five hundred years. During this time the building has become smaller and more complex in design. Only in the last two periods do we find it with a fire-proof masonry roof and sculptured decoration in stone and stucco.

The building has been rising higher and higher and, therefore, more remote from the common people who watched the proceedings from the great court below. The rituals must have become more exclusive. In the old days of the first drawing, a good many priests could crowd into the temple and on the broad platform, and the people could probably pretty well see what was going on.

BESIDES this hint of changing relations between priesthood and ordinary folk, these drawings tell a story of practical considerations. The priests commanded, or the people willingly gave, an enormous amount of labor for religious building. But they did not reach their top achievements overnight. New generations, imbued

Photos and drawings by William S. Godfrey, Jr.
Dissecting the Guatemalan temple. Two men stand on the stairways shown in the first two drawings on the opposite page. A stucco Sun-God mask glares at the right

with a "bigger and better" spirit, tore down here and there. This was, perhaps, to get building stone for new works more easily. But they did not waste the labor of their ancestors by removing whole platforms. They built new ones over and around them, sometimes, as here, making use of parts of the oldest walls to the end. So they gained grander and grander effects with the least labor. The great high "pyramids" of the Middle Americans *evolved*.

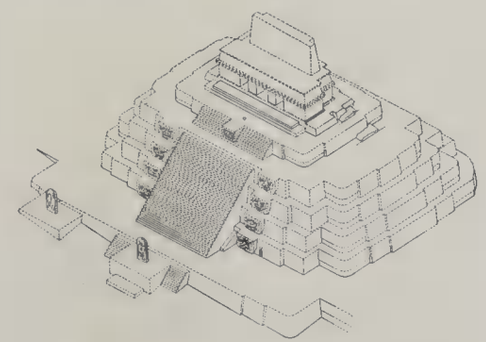


Four stages of the odd 500-year evolution of the Maya temple, as it was modified by succeeding architects who were not content to leave well enough alone

THIS is important to know. Many books state that the Indians were taught to carve and build by wanderers from Egypt, Asia, or from continents now submerged in the oceans; the underlying idea being that the Indian civilizations did not evolve, and that their most advanced achievements were accomplished at the start. This would be expected if they had learned all their arts from the outside. As digging progresses, however, such sequences as these at Piedras Negras show, on the contrary, more and more clearly that the Indian taught himself how to cut stone and wood with stone tools, how to burn lime, and how to build progressively more imposing settings for the worship of his gods.

Middle Americans were obsessed with an end-of-the-world idea. The coming end apparently depended on the heavenly bodies. So Maya priests were astrologers, and studied the movements of the sun, moon, planets, and stars. They carved extracts from their calendrical calculations on stone monuments, or stelae. Two of these are shown in position in the final two drawings, and in the photograph on the opposite page one is shown propped up on its side at the left. Probably this was to help future generations of priests to improve their astronomical formulas by checking against past observations and predictions. One of the recorded dates in a full inscription was approximately that of the time it was carved and the monument set up.

With the hieroglyphs, scenes are often carved, apparently showing priests conducting rituals to avoid the evils indicated by the current calcu-



The fifth stage of modification

lations. Those at Piedras Negras are among the finest, and mark a peak in Indian sculpture. That is one reason why this seemed to be a good place to dig. The carvings to be rescued, and new ones to be discovered, were of the finest; Dr. Mason saved many. In addition, here was the longest series of legibly dated monuments. This promised a maximum chance to use the Maya calendar in working out the development of their architecture.

We will give an example of how these carved dates can be used. Some day we shall know what the date on the central monument in the fourth and fifth figures is, in terms of our own calendar. About 675 A.D. is more than a guess, but this may be wrong. We can call it "Date X" for the present. The masonry roof on the building of the fourth drawing rests on an inverted, V-shaped, false arch, or "Maya vault." The fact that it first appears with the monument makes us fairly sure this vault was built about the time of the monument; that is, at Date X. It is one of the simplest and most easily built vaults at Piedras Negras, and therefore probably one of the earliest. Far to the east, at another site, the Carnegie Institution of Washington also has been dissecting Maya buildings. There they found a building with a vault which was erected earlier than an associated monument. The monument date is much earlier than Date X, which places that vault much earlier than ours. We have made a start toward proving that the vault was invented by another Maya group to the east. In time its use spread to Piedras Negras. Thus can an item for an outline history of Maya architecture be obtained.

A modern bomber synthesizes ideas from many sources: Explosives were invented in ancient Asia, rubber came from the American Indians, the fundamentals of radio from Europe, and the practical means of flight from white Americans. So, on a smaller scale, but in an entirely similar manner, one ancient Middle American group borrowed what it thought it could use from another, whether the borrowing involved a plant, like corn or tobacco, a deity, or a method of building construction.

The fact that, after feeding and housing themselves, these ancient Indians devoted most of their labor and genius to their gods is all to their credit, for they thought this was necessary in order to preserve their way of life for their children. Their religion, like our war, was "all-out" for the good of the tribe.

A workman points to an altar hidden in a cavity behind the shoring of poles

Food For Fighters

New Dehydration Process Uses Steam Baths and Heat Treatments to Reduce Vegetable Weight and Bulk

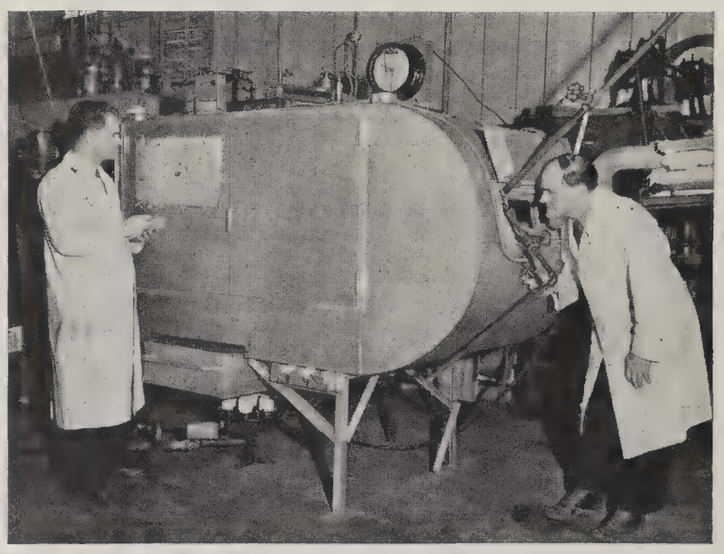
ANDREW R. BOONE

SINCE it is still true, during these days of high-speed tanks, jeeps, and sundry other wallop-packing vehicles, that an army travels on its stomach, Uncle Sam intends that American soldiers and sailors shall enjoy body-building and health-giving vitamin-laden vegetables along with their meat and dessert, at all distant outposts. Particularly will carrots, onions, cabbage, and potatoes be present on daily Army and Navy menus.

All vegetables contain large amounts of water, and water is heavy and bulky. Thus, when a food ship pulls into some distant outpost, bearing fresh or canned vegetables, nine tenths of the load is water, which is costly both in ship space and time to transport, and utterly without value as a food.

To avoid this wasteful practice, the army plans to feed military men in Alaska, Eritrea . . . on a score of fighting fronts . . . millions of pounds of dehydrated vegetables during coming months. When a company cook, fretting about the dinner menu, starts to prepare the evening meal, he will open two or three five-gallon tin cans, scoop out a few pounds of peas hard as baked clay and sweet corn more wrinkled than a sun-dried prune, and a half-dozen compressed cabbage disks. He'll toss the peas, corn, and cabbage into kettles of cold water. Thirty minutes later, he'll start these vegetables simmering. Another half-hour, and the vegetables will be ready—sweet, attractive, and nearly as fresh to the taste as the day they were harvested back home.

Researchers in a laboratory maintained by the United States Department of Agriculture at Los Angeles are seeing to it now that these foods will reach the fighting fronts bearing virtually all the food values of fresh vegetables. There Dr. E. A. Beavens, and others, working under direction of Dr. E. M. Chace, chairman of the department's dehydration committee, have discovered means not only of preserving the vegetables for long periods in all kinds of climate, but also of retaining virtually all the vitamins A and B, and more than half the vitamin C. Keeping vitamin C, number one scurvy preventer, which dissolves in water and just seems to evaporate from both leafy and solid vegetables between the field and home, is an achievement of the first magnitude.



Dehydrator for selecting vegetables for processing

In this "house of dehydration," Dr. Chace and his associates have solved a problem of many years' standing. Key to their taste-color-texture-vitamin preserving method is a combination steam bath and dehydration process, the latter being accomplished in a small plant containing features so new they haven't been patented yet. Here garden-fresh cabbage and carrots become brittle shells of their former selves in two hours. Two large heads of cabbage, enough to feed 20 hungry men, are compressed, after dehydration, into a disk small enough to fit in the hand. Yet, in those few ounces, there is enough cabbage to feed those same ravenous appetites.

Suppose we follow the trail of a batch of carrots through the new process. We'll start with six crates, each weighing 33 pounds. They were pulled an hour ago, and now they're being topped, trimmed, washed, and scraped. Clean and crisp, just as you would serve them for dinner, they are cut into disks about a quarter-inch thick. After being spread evenly on wire trays, they are placed in a square receptacle resembling a laundry tub, and covered. For six minutes steam rises from jets below, scalding each bit thoroughly. This process is called blanching, and it performs the important task of inactivating the enzymes, organic catalysts which cause chemical transformations in plants, thereby halting processes which ordinarily would destroy the color, flavor, and vitamins.

From the steam bath, the carrots are carried to the nearby dehydrator. This device, built undersize for experimental purposes, resembles a medium-size, all-metal automobile trailer standing on rigid legs. It is not intended to dry large quantities of vegetables, but, as Dr. Beavens explained, makes possible the selection of the varieties which will yield the best dried products. Within, after the doors are closed, air flows along baffles of a newly developed pattern, passing in parallel lanes over the material. Flowing at high velocity, from 900 to 1100 linear feet a minute, with the temperature carefully regulated in the 150 to 180 degree range, the dehydrator will turn out the dried food in periods ranging from an hour, for spinach and other greens, to four hours for corn.

But back to the carrots. The contents of six crates require several runs. So we wait, and at last we have a small pile of crinkly disks. We weigh them. Seventeen pounds. They fill two five-gallon cans. Were they intended for army use somewhere across the world, the shipper would drop a small chunk of dry ice into each can before filling it. He would seal the lid tightly with shellac. The dry ice, turning to gaseous carbon dioxide, would halt any oxidization, preserving the contents of the can for a year or longer. And the two cans would occupy about one-ninth the space now required for six cases of fresh or frozen carrots on that heavily laden transport.

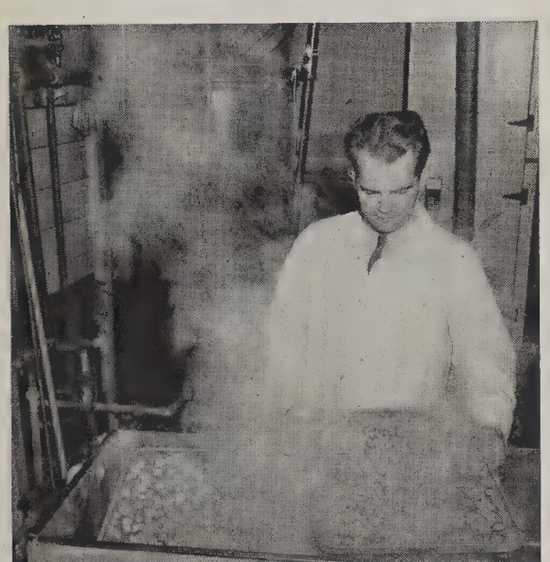
Our fighting men are due for more surprises, now hatching in this laboratory. While the war department is mainly interested in carrots, onions,

cabbage, and white potatoes, Dr. Beavens is hard at work on sweet potatoes, string beans, lima beans, peas, chard, mustard and other greens. He faces three "musts" before the army will accept his results. The vegetables must keep well in all climates for at least a year, they must rehydrate within an hour, and 92 percent of the moisture from potatoes and from 95 to 97 percent moisture must be removed from all other vegetables.

Speaking of spuds, Dr. Beavens has already achieved a dish that will delight fighting men yearning for steak and French fries. He's going to give them shoestring potatoes. They'll look like dried string when they tumble from the can, but a brief soaking and quick frying will restore their firmness. Even "canned willie" will taste like T-bone when accompanied by this delectable morsel.

Seven firms produced 7,000,000 pounds of dehydrated vegetables last year. Then the British began asking for dehydrated tomatoes, and inquiring about dehydrated carrots. Arizona carrots got a big boost recently when Margaret C. Smith, University of Arizona chemist, reported the copper state's product contains from three to ten times more carotene, source of vitamin A, than other carrots.

"Carrots," reported an R.A.F. officer, "ought to give our fliers cats' eyes by preventing night blindness." Walt Disney drew up three sketches showing carrots winging their way through the sky. Copies, wired from Hollywood to London, are posted in all R.A.F. barracks, urging pilots and bombardiers to eat carrots in all available forms. As a result of inquiries, from fighting forces both at home and abroad, production is zooming. It is estimated 25,000,000 dehydrated pounds of all vegetables will be produced during 1942—enough to provide 300 servings for 1,000,000 soldiers.



Steaming (blanching) at 212 degrees, Fahrenheit, precedes dehydration of carrots

Cabbage before and after dehydration. Two heads (four pounds) shrink to a six-ounce disk. Disk is compressed from shredded leaves (at right) after dehydration

Civilians will get to know these foods better, too, as time goes on and transportation facilities take on heavier defense loads. Although most popular now in the nation's markets is a little package containing a scoop of chicken fat, some noodles, and pieces of dehydrated vegetables, which becomes a quart of noodle soup after the addition of water and a few minutes' boiling, you can also get several other soup-making mixtures and such individual items as potato shreds, onion flakes, carrot cuts, pea and bean powders, tomato pieces and flakes, and spinach and celery flakes. In each case, all you need do is add water, heat, and eat. They'll increase in weight from eight to 40 times their dry weight as they take up water. But all the food essentials are there, just as in canned and fresh vegetables.

Don't let the word "dehydration" fool you into thinking you'll get tough, stringy, hard-shelled beans and carrots and peas and corn, when these vegetables are prepared by the modern method. True, dehydration means that nine tenths or more of the water is removed. Processes developed in the last few months do that, and more. After you rehydrate the vegetables in your kitchen and simmer them a half-hour, they're practically as good as garden-fresh vegetables.

The other afternoon I carried home from the Los Angeles laboratory four samples: A scant handful each of dehydrated corn, small lima beans, and mixed peas and carrots. They had been dehydrated in the new apparatus nearly two months earlier. The beans were almost hard as rocks; the corn, shrunken to a fourth its natural size, brittle and sugary; the peas and carrots only apparent shells of their former selves.

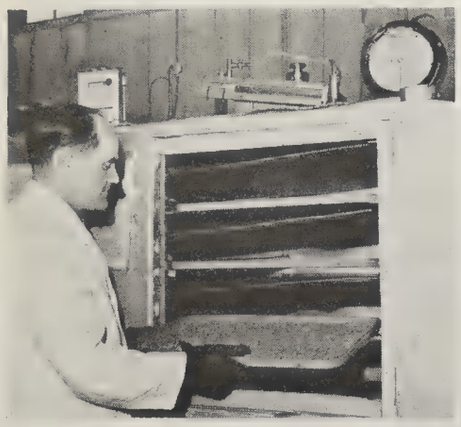
That evening, the samples were soaked a half-hour in cold water, then simmered a half-hour. When fully done, we had enough to feed eight people. All four vegetables had returned to their normal shapes and sizes, the peas had their accustomed green sheen and the corn looked as if it had just been cut from the cob. Except for a stray kernel and an occasional pea, all were sweet and juicy. Had I not seen them before cooking, I would not have known them from fresh.

We stay-at-homes know little of the dietary deficiencies which soldiers suffer when they go without fresh fruit and vegetables for a long time. One of the dread diseases faced by fighting men on some distant desert or arctic base, should their supply lines be cut, is scurvy. As early as the Civil War, semi-dehydrated vegetables were fed Union troops, but they were unpleasant to the taste, and possessed no anti-scorbutic properties. Again, during World War I, both the Germans and Americans used dried vegetables. Many doughboys fighting in France will remember dumping his ration on the ground to avoid eating them, but these vegetables were entirely different from those which are now being made available.

Once tasteless and lacking in nutrition, dehydrated vegetables now provide both food and medicines. In a wide-scale California experiment, nutritionists and chemists for Ana-

bolic Food Products, Inc., are feeding 20,000 acres of parsley, turnip greens, and beets special diets to increase their tissue-building values, and possibly to add a little extra zip in the form of vitamin C. The diets are prescribed after analyses of the soil and water indicate what plant foods are deficient.

Formerly potash, phosphorous, and nitrogen were thought to be the essential food elements for growing plants. Now, in addition to the Big Three, the dehydrators are turning their attention to the so-called trace elements such as boron, manganese, sulfur, calcium,



Removing carrots from dehydrator

iron, and phosphorous. Dr. J. W. Wigelsworth is cultivating super-vegetables, and already has turned out strains of leafy plants containing three times the average amount of iron.

When these dehydrated vegetables reach far-flung American military and naval fronts, soldiers and sailors alike may be sure they're getting more iron in their parsley, added bone-building calcium in their turnip greens, extra manganese in their beet greens, and abundant copper in the green sprigs of parsley.

Army chiefs know soldiers will complain, no matter how tasty the chow. But they're making sure the steamed and dried carrots and peas, and all their kin, will return to their original form, size, and appearance; cook tender; and give off nearly all the odor and flavor of the fresh article. They may be bone dry at 11 o'clock. But when the chow bell rings at high noon, they will be "garden fresh."

In fact, recent tests at the University of California showed dehydrated peas, string beans, carrots, and spinach to be actually superior in color, after cooking, to the canned product.

When it comes to shipping, as has been pointed out, great savings will be effected. One pound of dehydrated pumpkin contains 12 times more fuel value than a pound of fresh pumpkin. Not only does a ton of fresh cabbage yield 215 pounds of the dehydrated product, but the fuel value of the dried leaves actually equals 2279 pounds of cabbage freshly boiled in the kitchen. One cargo ship will do the work of 16 when it comes to hauling tomatoes, because this vitamin-rich vegetable loses 93 percent of its weight when dehydrated.

Those are some of the reasons why Uncle Sam is so interested in food during this war, and they explain how he is planning to carry more bullets and bombs to distant places without cutting into food rations on the firing line.

• • •

HALLUCINATION

You Can Be Trained To "Hear Things"

PERFECTLY normal persons can be taught to "hear things" where there is no sound. Details of how such hallucinations can be produced by the simple form of learning known to psychologists as "conditioning" have been reported by Prof. Douglas G. Ellson, of the University of Mississippi.

Nearly half of a group of subjects taking part in Prof. Ellson's experiment under the most favorable conditions, learned to hear a tone when it was not being sounded. They had been prepared to "hear" it by a learning period during which the tone was sounded regularly every 30 seconds for 30 repetitions.

When the actual sounding of the tone was introduced and ended gradually, the subjects tended to have the hallucination of a tone after it had ceased to sound. If the start and termination were abrupt, however, only a few (8.5 percent) developed the hallucination.—*Science Service.*

POISON IVY

Infection Prevented by Protective Ointment

AN IMPROVED protective ointment against poison ivy has been developed and proved effective by the United States Public Health Service. The new ointment, made with either of two bases, will remain effective for several weeks if kept in a closed container.

The ointment should be thickly applied to exposed parts before contact with poison ivy. Clothes must be removed after exposure before the ointment is washed off, otherwise the unprotected skin may be exposed to clothes which have been contaminated. Tools and instruments or clothing which have been used in cutting poison ivy must be decontaminated before being used again. Decontamination can be effected by washing clothes or immersing tools for 15 to 20 minutes in a 1 percent solution of calcium hypochlorite.

The two formulas were developed by Drs. Louis Schwartz, John E. Dunn, and F. H. Goldman of the Public Health Service:

Formula 1

Castor oil	21.5%
Olive oil	21.5%
Lanolin, anhydrous	21.5%
Diglycol stearate	12.9%
Paraffin, refined	8.6%
Boric acid	2.0%
Sodium perborate	10.0%
Duponol WA pure	2.0%

Formula 2

Cetyl alcohol	35.1%
Stearyl alcohol	5.3%
Ceresin	3.5%
Castor oil	20.8%
Mineral oil	21.9%
Duponol WA pure	1.7%
Sodium perborate	10.0%
Boric acid	1.7%

IN THE BRAIN

Sex Perverts Found Not Lacking in Hormone

DRAMATIC transformation of seven "somewhat effeminate," jealous, jittery young men into he-men with beards, an interest in girls, and enough ambition to advance in their professions or to get off relief rolls into regular jobs was recently reported by Dr. Jacob Kasanin, director of psychiatry at Mount Zion Hospital, San Francisco, and Major Gerson R. Biskind, Letterman General Hospital, San Francisco.

These young men had undeveloped male sex glands, but had not "become sexually depraved in the sense of becoming interested in homosexuality," the physicians reported. Treatment with the male sex hormone, testosterone, by implanting "banks" of the hormone in their muscles to supply the deficient amount from their glands, brought about the personality changes reported.

A group of patients examined on account of homosexuality, on the other hand, did not show any evidence of lack of sex hormone secretion. "This points to the fact," the physicians conclude, "that homosexuality and sexual perversions are probably psychological in origin."—*Science Service.*

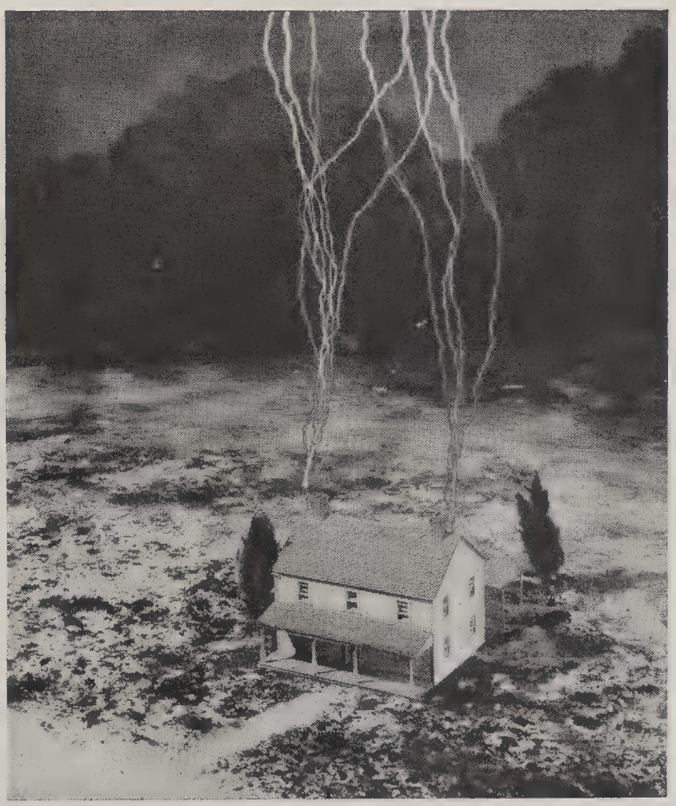
When Lightning Strikes

Applied Research Has Reduced Greatly the Damage Done by Natural Lightning, Yet Much Study is Still Ahead

Dr. GILBERT. D. McCANN
Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

EACH year about 16 million thunderstorms occur on the earth, causing an average of about 50 lightning strokes to the earth each second, or a total of about two billion strokes a year, which are a potential source of destruction. If these strokes were equally distributed, about eight strokes a year would strike each square mile of the earth's surface.

In the United States alone lightning strokes cause about 400 of the annual 92,000 accidental deaths, about the same number as street-car or airplane accidents. They produce some $12,000,000 worth of damage to farm buildings, 55 percent of all oil-tank fires, and untold damage to forests through fires. Lightning constitutes a serious hazard to aircraft, munitions dumps, and explosive manufacturing processes. It is a hazard and a source of interference to both telephone and radio communication. Electric power systems, however, constitute by far the greatest potential targets for lightning destruction. The extensive character of transmission lines and distribution systems contributes to their being struck frequently by lightning, and maintenance of continuous service and prevention of damage to equipment places stringent requirements on lightning-protection devices of various types.



A model house protected from artificial lightning by lightning rods. Although the rods were struck many times, neither house nor nearby trees were hit

There are today in the United States about 83,000 miles of high-voltage transmission lines transmitting large blocks of power from our 42 million kilowatts of generating machines to many load centers. Lightning is by far the most serious cause of trouble on these lines. Aside from the serious damage it can cause to electrical equipment, the loss of service it can produce not only results in considerable inconvenience to power consumers but also may produce damage and result in the loss of many hours of operation for certain types of manufacturing processes for which even a momentary loss of power is serious. Maintenance of continuous service is particularly important in these times of national emergency.

Studies of the number of times transmission lines are struck by lightning reveal that in the eastern part of the United States a mile of line is struck, on the average, about once a year. Thus, a 100-mile line would be struck 100 times. Storm density, of course, varies throughout the country, but it is estimated that the 83,000 miles of transmission lines are struck at least 60,000 times a year.

Twenty-five years ago knowledge of lightning and the protection of power systems was so limited that every time a line was struck at least a service interruption occurred. Today, through knowledge gained by lightning research, a 100-mile line can be protected so that it does not have an outage more than once every four or five years, instead of 100 times a year.

In addition to high-voltage transmission lines, many thousands of miles of distribution circuits feeding individual consumers in both rural and urban areas must be protected from direct strokes and from induced voltages produced by a lightning stroke in the vicinity of the line. The electric fields associated with a stroke may produce dangerous voltages on such circuits.

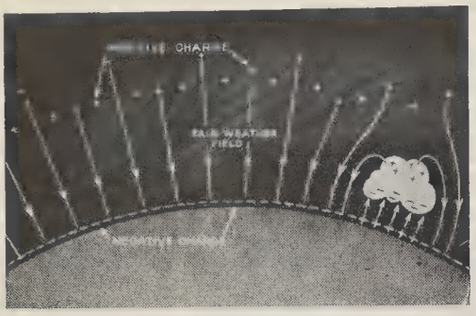
Through co-operation of the public utilities and electrical manufacturers, and through the use of special recording instruments, such as the Klydonograph, cathode-ray oscillograph, surge-crest ammeter, Boys camera, and the Fulchronograph, valuable information has been obtained regarding the mechanism of the stroke discharge and the voltages and currents associated with lightning. Also of great importance have been the data obtained by the United States Weather Bureau on the variance of storm density throughout the country.

This knowledge has led to the use of ground wires and vertical grounded masts located over and around transmission lines and substations to intercept lightning strokes and conduct their high currents harmlessly to earth, thus preventing lightning from directly striking live conductors carrying power. Their principle is similar to that of lightning rods on buildings. Contrary to a common belief, lightning rods, properly applied, provide effective protection. This misconception has largely been due to the fact that a great many applications in the past have been faulty and ineffective. This type of protection has also been found applicable to oil tanks, munitions dumps, or any object that can be damaged by a direct lightning stroke.

Voltage-limiting protective devices such as lightning arresters have been so perfected that they effectively limit voltages produced by lightning on power systems to magnitudes which will not damage equipment. They are also used effectively for protection of radio transmitters and telephone equipment. The Bell Telephone Company has so developed lightning

protection of its systems that loss of service rarely occurs and it is quite safe to use the telephone during thunder storms.

It has been found possible to duplicate many of the important properties of lightning in the laboratory and thus study the performance of protective devices. The voltages and currents associated with lightning are of extremely high magnitude—millions of volts and hundreds of thousands of amperes — but they are frequently only a few hundred-millionths of a second in duration. However, it has been found possible to duplicate and measure them. It is possible also to reproduce the essential characteristics of the stroke discharge from cloud to ground in model laboratory sparks and thus study with model transmission lines, substations, and the like, the performance of shielding ground wires and vertical masts.



When the air, a low-value conductor of electricity, can no longer withstand the electrical stress of the field of a thunder cloud, lightning strikes and the electrical balance between earth and air is restored

It is important to measure and study the electric and magnetic fields produced by lightning strokes. These are the source of "static" interference in radio reception, a type of interference which also bothers telephone circuits. These fields are so intense and of such high frequency that they can induce dangerous voltages not only on power and telephone circuits but also in certain manufacturing processes using explosive materials. A spark caused by a flashover from such an induced voltage is a potential source of explosion or fire. This is a problem which has become more important with the expansion of our war industries. The most effective way to eliminate this hazard is to shield the building or area in which the explosive process is taking place with a conducting shield or "Faraday cage" which completely surrounds it. This prevents the penetration of the electrical field produced by a lightning stroke.

Lightning is a hazard to all types of aircraft. Captive balloons attached to conductive cables are likely to be struck during a thunderstorm, and airplanes are sometimes struck by being in the path of a stroke to ground while flying below a thundercloud or by precipitating a cloud-to-cloud discharge while flying in the thundercloud itself. Aircraft can become electrically charged while passing through a thundercloud, and when they land they may be discharged by a spark which can be hazardous. This is particularly true of seaplanes making forced landings, as they often lighten their load by dumping gasoline.

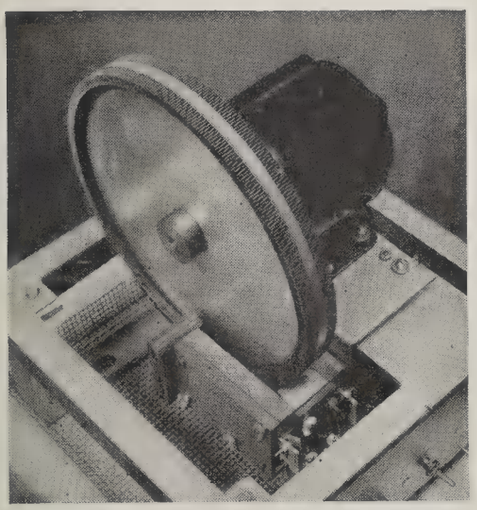
Artificial lightning strikes the models

For the solution of such problems a knowledge is required of the fundamental processes involved in the formation of charge in the thundercloud. The energy of this charge formation is supplied by highly turbulent upward air currents, which are essential to the formation of the cloud itself. This turbulent condition in the cloud is also important as a hazard to aircraft. It also is essential to the formation of precipitation. Thus, the electrical properties of a thunderstorm are closely associated with all of its other properties and for this reason of much concern to meteorologists.

Building a miniature transmission line for studying lightning effects

THE thunderstorm plays an important and fundamental role in the natural state of the earth. Although it is not commonly realized, the earth, besides being a magnetic body, is also electrically charged. We are all familiar with the fact that there are magnetic fields produced by magnetic materials concentrated mainly at the North and South Poles. However, there is also at all times a negative electric charge distributed over the surface of the earth and a positive charge in the outer regions of the earth's atmosphere. These two sets of charges produce an electric field in the air directed vertically toward the earth.

During fair weather this field is about 30 volts per foot at the earth's surface. Measurements of the charge density on the earth indicate that the total charge on it is at all times about 500,000 coulombs. Owing to a certain degree of conductivity of the air in the form of free ions, the air has a low conductivity and the presence of the electric field produces a leakage current from the earth, tending to discharge the earth's negative charge. If it were not for some restoring agent the earth would be completely discharged in five or six minutes by this leakage current. Lightning plays the fundamental role of returning this charge back to the earth and maintaining it in its normal charged condition. Thus, there exists a continuous cyclic process of discharging and recharging the earth. The key to this process is the ionization of the earth's atmosphere which makes possible its conductance and the leakage current. This ionization also plays a role in the formation of the charge in the thunder cloud and the breakdown of the air which produces the spark discharge of the stroke to earth. This ionization is produced by three sources:



This motor-driven wheel, carrying many small steel strips on its periphery, measures lightning. When lightning strikes, a small coil magnetizes each strip as it passes a given point. By later measuring the magnetism of each strip, a fairly complete picture of the lightning stroke can be drawn for further careful study

1. Alpha, beta, and gamma rays (or X-rays) emanating from radioactive minerals in the earth's crust. 2. Radioactive gases in the atmosphere, which are products of decomposition of radioactive minerals in the earth. 3. Cosmic rays emanating from the outer universe.

Lightning is not altogether destructive. It is also a beneficial agent to plant life, for it produces in the air large quantities of nitrous acid which are carried into the soil by rain. It is estimated that the 16 million storms that occur annually produce about 100 million tons of this fertilizing agent. This gigantic amount exceeds by far the total output of the nitrogen-producing industry.

As a result of the concentrated efforts of the various research organizations that have been studying lightning and the electrification of thunderstorms, great strides have been made in the past 25 years and many of lightning's properties have been well established. Also, many of the problems of protecting against its destructive effects have been overcome. However, there are still important properties of lightning about which more knowledge is needed, and although considerable progress has been made, many questions still remain for further investigation.

• • •

BLACKOUTOLOGY

Why Red Light is Better than Blue

EYES have two-way vision—one set of sense organs (the cones) for daylight seeing and the other (the rods) for darkness. Both operate at the same time only when the light is about as bright as full moonlight. Differences between the eye as a night-vision instrument and the daylight eye, important for night warfare and blackouts, recently were described by Prof. Selig Hecht, of the Laboratory of Biophysics, Columbia University.

Night eyes are thousands of times more sensitive than are day eyes. The night pilot who has been flying in the dark for an hour or more could see the light of a candle 12 miles away even if it were exposed only for a thousandth of a second. If it burned continuously, he could see it over 200 miles away, were it not for interference of fog and haze at night, or for smoke and the curvature of the earth. For this reason it is dangerous in a blackout to use a flashlight, or light a match or even a cigarette in an open space. The flame of a match can be seen by a pilot many miles away.

On the other hand, night eyes cannot see as *sharply* as day eyes. When it is necessary to recognize small forms and slight differences in shade and shape, you must have good lighting and use your daylight eyes. You need your day eyes to read an instrument or your watch.

But the brightness of different colors is not the same when you see them at night as when you see them in the daytime. This is particularly important when you want to use colored lights to see best during a blackout without giving aid to the enemy. Blue and green are easiest to see. Red and orange, which seem so conspicuous in the day, are hardest to see at night.

Nothing could be more dangerous than the use of blue lights during blackouts, Prof. Hecht declared. "For reasons which are none too clear at present, the notion has gained prevalence that blue lights should be used to illuminate objects, and that these would furnish less light to distant aviators because blue is supposed to be a dim light. Indeed, the Germans and the English, and at the beginning we ourselves, used blue lights during blackouts."

When we need a light during a blackout—to watch a dial, read a compass or a road sign—we must use our day vision for this purpose. The enemy aviator, however, needs only his night vision in order to spot that light.

Your night eyes and your day eyes happen to be equally sensitive to red light. If you see the light at all, you can also see it with your color-sensitive day eyes and you have the day vision's advantages of ability to recognize shapes.

But, for blue light, your night vision is 1000 times more sensitive than is your day vision. In other words, if you have enough blue light so that you can see a road sign, the light will be 1000 times as bright to the night-seeing pilot as would be a red light of equal effectiveness.—*Science Service.*

• • •

WOOD FARMING—Mississippi farmers now are planting millions of pine seedlings provided by the Masonite Corporation, manufacturers of hardboard and insulation-board products. The new industrial demand for pine wood has given cash-crop value to land previously considered worthless in the South.

• • •

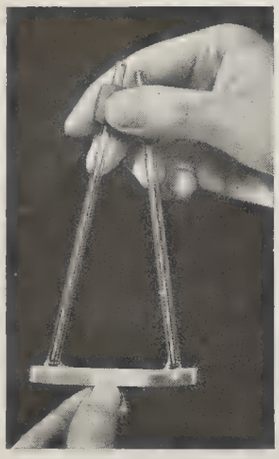
TEST FOR pH

Made Quickly With Simple Equipment

CONTROL tests for pH (degree of acidity or alkalinity of solutions) can now be made rapidly by unskilled workmen with simple equipment. Also, quick preliminary tests can be made in laboratories where more elaborate pH apparatus is available.

The simple technique of pH testing using the Cargille Buffer Set depends upon the use of 17 buffer tablets which, when dissolved as directed, provide 17 solutions of known pH value.

These solutions, applied to a strip of test paper, bring out a specific color on the paper for the pH value of the solution used. Thus, when making tests, a drop of the solution to be checked is placed on the test paper and the resulting color is compared with the chart furnished with the paper. A solution of known pH value, close to the pH value indicated by the first test, is then placed on the test paper



Checking color produced on test strip by sample and by solution of known pH gives quick determination of pH of the sample

beside the sample. By proceeding in this manner until differences in color are scarcely perceptible, the pH value of a sample can be quickly judged to about 0.5 pH unit.

It is claimed that color comparisons made in this manner are more accurate than those which are made with a color chart alone.

JAP NYLON

May Enter World Markets— After the War

JAPANESE industrial chemists are already preparing for an industrial struggle to follow cessation of the shooting war. This is the conclusion that may be drawn from three articles published in Japanese, in the *Journal of the Chemical Society of Japan,* during 1940 and 1941. The author, K. Hosino, research man for the Oriental Rayon Company, Ltd., tells how he analyzed nylon, the synthetic plastic fiber that has made the United States independent of silk. After he had determined how the molecules were put together, he duplicated them and then made modifications which he claims are improvements over the American product.

This procedure, reminiscent of pre-war tales of how Japanese mechanics would build a duplicate of any machine that Occidental manufacturers would sell to their employers, might give Japanese textile factories the means to compete to great advantage with nylon mills in this country and Europe. Japan has persistently refused to enter into any patent treaty with any foreign country, so that the du Ponts, originators of nylon and owners of basic patents thereon, will have no protection against Japanese attacks on their business, especially in the export market.

Nylon, the Japanese chemist states as a result of his analysis, is a "polyamide of hexamethylenediamine combined with adipic acid."

If Japan goes into the nylon business, the silk industry, already hard hit first by rayon and then by the cessation of American silk purchases even before the outbreak of war, may never come to full revival. It is reported that hundreds of thousands of mulberry trees have already been felled in Japan, to make room for more food-crop production. Quite possibly these groves may never be replanted. Silk may again become what it was in the Middle Ages and early modern times—a luxury for the rich.

• • •

PROTECTION — Tiny robot sentries — new secret devices built into miles of high wire fences enclosing some of the nation's great war production plants—are said to be saboteur-proof by du Pont engineers who developed the system. The acoustic fence "overhears" birds chirping, the snip of a wire-cutter, the scrape of a shovel, even whispers, relaying these sounds to a central control room from whence a squad car rushes to the precise point of disturbance.

• • •

SALT ROADS

Wear Better, Resist Frost

THE practice of using rock salt in the subsurface of roads, which originated in Nova Scotia as a means of protecting roads against extreme winter conditions, is spreading in this country with remarkable results reported. First employed to keep frost from heaving the road surface, salt has been found to do more than serve as an anti-freeze. Through a simple action it also stabilizes the soil used in the subgrade so that the road bed is firmer, giving longer life to the wearing surface.

One of the most interesting examples of subsurface treatment with salt is found in Cayuga County, New York. The first salt road in Cayuga County was built in 1936, and in succeeding years additional salt roads have been laid down. According to Gail Ball, County Superintendent of Highways, none of these roads show any sign of frost damage.

"Employing a system that we have used successfully ever since," he said, "we first used the salt not in the subsurface but in the original surface. We were convinced that salt worked into the surface would give us a longer-wearing road and we put down about eight tons of rock salt to the mile, raking and rolling it in. After two years, in which the salt-surfaced road held up excellently, we gave it a light sprinkling of salt, and then put on a macadam surface. Although other untreated roads nearby have suffered severely from frost since that time, this road has shown no frost damage whatever. We feel that we are getting extra value from the salt in this matter of frost-heave prevention, since that was not our primary purpose in using it."

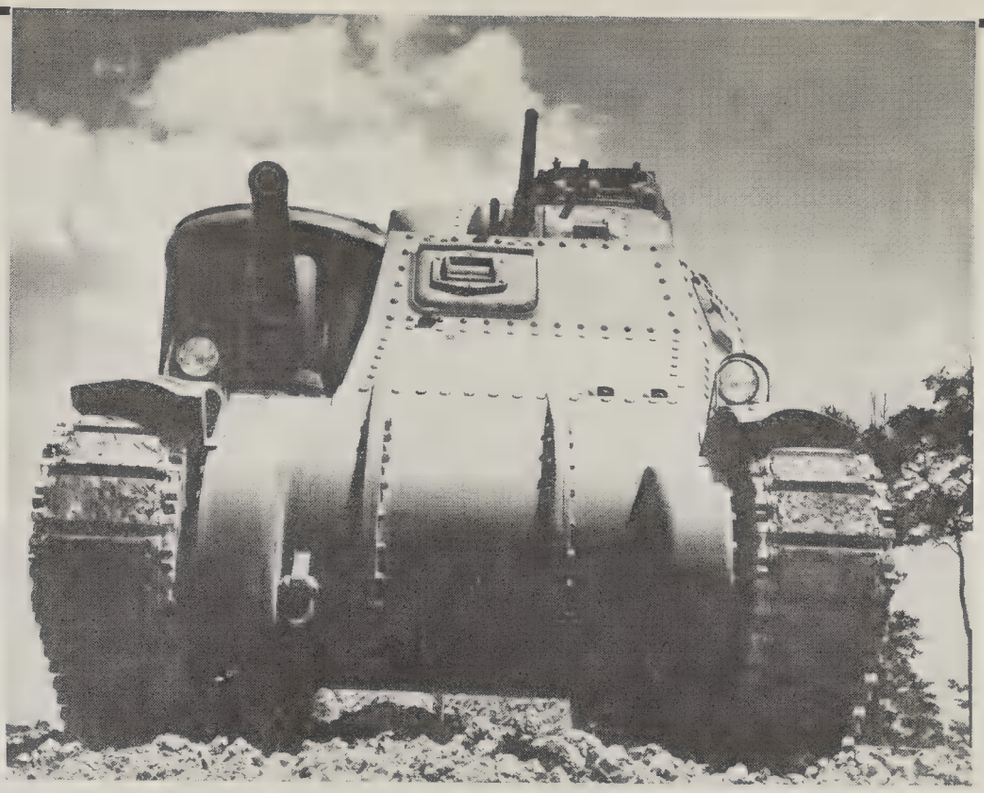
EMPLOYEE DESIGNED

Work Simplification Program Aids Production Drive

AN assembly fixture, designed in his spare time by Albert Wender, an employee, and manufactured out of scrap materials, has raised the output of siphon tubes for Army tank fire extinguishers from 100 to 400 parts per eight-hour shift at the New Jersey plants of Walter Kidde & Company. John Space, another employee, has worked out another scrap steel device that increased the output of valves for gas-type airplane fire extinguishers by 25 percent. Gains of 71 and 100 percent in other typical assembly operations have resulted from this showing of employee inventiveness.

These are the tangible results of the Work Simplification Program that is playing a major part in the war production drive. This program, which was inaugurated two months ago, is itself the invention of a Kidde employee—B. P. Corcoran, who until recently was a worker on the assembly line. Night school courses acquainted Mr. Corcoran with the principles of motion study, and his years of ex-

John Space and his scrap-made unit



Men in the Armed Forces
—Soldiers, Sailors, Marines—

Would Appreciate a Gift Subscription to Scientific American

AS a gesture to those hundreds of thousands of American men who have severed their home and business ties to do their part in building up the Army, Navy and Marine Corps of the United States, Scientific American is making a special offer of half-rate subscriptions when mailed to members of our armed forces.

Keep the boys informed of the happenings in Science and Industry which are so important to our present-day economy, and which will be doubly important to them when they return to civilian life. Send us the names and addresses of those members of the services to which you want the magazine sent, enclosing only $2 for each one (regular subscription price is $4 a year) and we will mail Scientific American regularly to each one of them for a period of 12 months.

There is a constant call for reading matter from all branches of the service. Here is your chance to make life a little happier, a little fuller, for the boys by sending them the one magazine that gives them accurate and authentic information on progress in a wide range of fields. Just fill in the coupon below (use a separate sheet if you need more room) and send it to us with the correct remittance. We will do the rest.

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perience as a worker gave him the idea of applying these principles to the men themselves.

The basis of work simplification is the fact that the man on the job often knows more about improving that particular job than a highly trained engineer. The basic problem is how to bring out these ideas and the two major difficulties are expression and shop psychology.

Under the Work Simplification Plan, the workmen work out their own ideas and present them as accomplished facts. The starting point is the foreman or group leader. Regular classes are held for these men in which they are acquainted with the principles of motion study, expressed in simple shop language rather than engineering terms. In these classes they are given assistance in working out their own ideas, and prepared to help the men under them.

In addition, a machine shop, completely equipped with hand and power tools, has been provided for the employees so they can develop their own devices. Employees can use this shop either on their own or on company time, and a skilled machinist is always present to aid the worker with an idea.

CORRECTION

In "From The Ground Up" Article

SEVERAL of our readers have called our attention to discrepancies which appeared in the article "From the Ground Up," by Douglas M. Considine, which appeared in our June 1942 issue. In the last paragraph of the second column on page 279 of the article, continued to the top of the third column, production of TNT should be read in pounds instead of tons. The same correction should be applied to the discussion of picric acid and smokeless powder, in the same paragraph. It appears that this error crept into the final typescript during transcription from the original.

MILK PROTECTION

Ultra-Violet Rays Kill Bacteria

A NEW U-shaped Sterilamp, using beneficial ultra-violet rays, may be the future means of keeping milk fresh for many hours longer, in addition to providing completely sterile bottles. Designed primarily for use in dairies, this new development of the Westinghouse Sterilamp may easily be adapted in other bottling operations such as soft drink manufacture, canning factories, and pharmaceutical concerns.

Highly efficient methods of washing milk bottles now employed by modern dairies may be improved upon by use of the Sterilamp, it is reported. At the present time, bottles returned to the dairy are put through a process of warm and hot water solutions. After that, the bottle is washed with germ-killing chemicals. At this particular point, the bottle is sterile, but it must be rinsed. Most city water used for that purpose has been proved

U-shaped Sterilamp in laboratory

to have considerable bacteria, and although harmless in most cases, they cause milk, if left standing, to turn sour.

The ultra-violet rays of the Sterilamp will correct this. After the bottle has been washed, it will pass along the conveyor belt to a battery of Sterilamps, one of which will be inserted in each bottle for a period of ten seconds, the time required to kill all bacteria. Then the milk will be poured into it immediately and a sealed cap will insure its purity.

ELECTRONIC GADGETEERING

May Replace "Hams'" Interest in Communication

FROM now on we shall see a rapid development of electronic gadgeteering—the non-radio application of radio technique—according to Charley Golenpaul, of the Aerovox Corporation.

"I believe the era of electronic gadgeteering is now opening up in a big way," states Mr. Golenpaul. "In the first place, the ban on amateur radio communications is not going to leave the enterprising 'ham' twirling his thumbs. Of course many 'hams' are already or will soon be in our armed and technical services. Many will find wartime jobs with other United Nations. But those remaining on the home front are going to put their experience, equipment, and ambition to work on new and startling applications in the home, shop, factory, and elsewhere, far removed from customary radio practice.

"I suppose most radio men have heretofore been too busy with radio proper to find extra time and energy for non-radio or electronic gadgeteering possibilities. However, many of them now are going to use their 'rigs' and parts for new functions. I can visualize some interesting developments — light-beam telephones for conversing over considerable distances; automatic photo-electric garage-door openers; photo-electric switches turning lights on and off with darkness or daylight; checking the stoking of furnaces or boilers by the chimney smoke; various comparators or instruments for comparing and matching colors and shades; checking solution concentrations and chemical studies by conductivity means; and so on.

"As a starter, electronic gadgeteering can be based on well-known elementary principles and basic circuits long known to radio and electrical workers. Many industrial plants are already electronic-gadget conscious. I know of radio servicemen who've gotten themselves good jobs in plants because of their ability to do things better, quicker, and less expensively by electronic means.

"Make no mistake about it, the temporary suspension of 'ham' communications may well turn out to be a boost. It will generate a lively interest in electronic gadgeteering. And when 'ham' communications are resumed again with the return of peace, I venture to predict that electronic gadgeteering will comprise a greater field for radio parts, particularly the quality or extra-heavy-duty components, than all amateur radio activities put together. Furthermore, many a 'ham' will find an interesting way of making real money out of his hobby, and that's something."

CELLULAR RUBBER

Is Light in Weight, Used in Life Rafts

NEW lifesaving devices, made of the newly-discovered cellular rubber, which has twice the buoyancy of cork, include a raft composed of a spider-like network of disks of the new material strung together with ropes, and self-lighting electric lamps which will float in the water beside victims of a sinking ship to guide rescuers at night.

Because of the extreme lightness of the cellular rubber, which is composed of millions of small cells filled with

nitrogen gas, the raft will support up to 30 persons, according to the United States Rubber Company. An advantage of its construction is the ease with which it may be grasped in the water. It is of particular significance in torpedo sinking because it can be thrown overboard when there is not time to launch a regular lifeboat or raft.

The new form of hard cellular rubber is also being used as insulation under decks of mosquito type torpedo boats, and the soft material in life jackets for the United States Engineers. Also, a fire resistant, hard cellular rubber is being used as supports of self-sealing gas tanks in airplanes.

SABOTAGE PREVENTION

Aided by Electron Tube Equipment

THE use of electron tube equipment for detection of intruders has become a major factor in protecting property from sabotage, according to a recent issue of *Electronics*. One company alone, it is stated, has installed 4100 photo-electric alarms, of which 1300 are operating outdoors. Capacity systems protecting safes and acoustic systems guarding vaults electronically are too numerous to estimate.

Electronic intrusion-detectors may operate "local" signals, ringing bells, blowing horns or whistles and turning on floodlights. They may also actuate "proprietary" system signals, calling guards from somewhere within the protected premises to the threatened point, or they may operate remote signals in "central station" offices maintained elsewhere by firms specializing in the installation, operation, and maintenance of protective systems.

For many years industrial, mercantile, and residential premises have been protected against burglary by electrical alarm devices supplementing the work of guards. Such electrical systems have now been joined by electronic intrusion-detection devices. These are proving useful where supplemental protection is desired, where series wiring cannot readily be installed and where alarms must signal at the approach of an intruder rather than after an attack upon premises or fixtures begins.

Photo-electric intrusion-detectors substitute a beam of light for older methods of protective wiring using foil pasted over windows or show cases housing valuable objects. Here, interruption of the beam projected from light source to light detector actuates a local or remote signal. Sharply-focused lenses, hoods, and masks, plus "modulated" light beams, simultaneously make it difficult for intruders to paralyze photo-electric alarm systems by shining the beam from a flashlight into a phototube and walking through while the relay is held in the stand-by position. Light-beams are very nearly invisible even in smoky or dusty air as most projectors now contain optical filters confining emission largely to the infrared region. Mirrors are generally used indoors to break beams up into curtains of light criss-crossing the area to be protected. Three or four reflections are commonplace and as many as a dozen have been successfully used.

Weather-proof cases and carefully chosen components which continue to function properly despite wide variations in temperature and humidity permit systems of the type described to function outdoors. Useful beam-throws of as much as 500 feet have been achieved by mounting projector and detector units on heavy pipes embedded in concrete blocks sunk into the ground to maintain alignment. Where extremely long beam-throws are required, duplicate projectors and detectors rather than mirrors are advisable for turning of property boundary corners. Because of other advantages inherent in design, such equipment is useful for indoor as well as outdoor applications where somewhat

THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

Confidence Rides With The Dawn Patrol

WHEN the bombers of the Atlantic Patrol thunder into the dawn, their pilots look ahead with confidence—confidence born of faith in their machines and the fuel that drives their motors. American fuels, like American planes, are built to bring back safely those who fly.

Somewhere, in an American refinery, one of America's great army of behind-the-scenes workers, with a Bausch & Lomb Refractometer, is doing his part in making American oils and gasolines so efficient and safely dependable. Modern refractometric methods of control speed refining operations and maintain a greater uniformity and higher quality than ever achieved before.

Here, again, optical science — with Bausch & Lomb instruments — is at work helping to strengthen America's front lines. Today, American manufacturers—like the nation's armed forces — turn to precision optical methods for critical analysis, precise measurement, quality control. Bausch & Lomb Contour Projectors, Metallographic Equipment and microscopes for inspection and control take their place alongside range finders, gun sights and binoculars in contributing to the vital needs of national war effort.

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greater cost appears justified by the additional protection afforded.

One unusual installation has guarded a waterfront stretch of nearly 3000 feet for more than five years, transmitting few false-alarms despite dense harbor fogs. A special projector unit using an 18-inch lens and an airplane beaconlamp (to widen beam-spread and avoid operation of the alarm by sea-gulls) was built for this job and the projector unit as well as the detector unit floats in comparatively calm tidal water off the end of a dock. Its purpose is to detect intrusion from the sea side of the property. Standard projector and receiver units have since been designed for such marine application.

• • •

SUN FOR HENS—Modern poultry farm hens now bask for several hours a day under portable sunlamps developed specially for animals. The new sunlamps, source of Vitamin D, eliminate the daily doses of cod-liver oil usually fed to chickens but now threatened by war shortages.

• • •

IT STRETCHES

Synthetic Rubber Thread For Military Uses

WHAT is believed to be the first synthetic rubber thread ever developed in this country has been made from Ameripol synthetic rubber. In announcing the development, W. S. Richardson, of The B. F. Goodrich Company, said:

"Primarily this development has been for military purposes, to conserve the natural rubber thread that formerly went into products used by our armed services. There is at present no possibility that any of the thread can be diverted to the manufacture of civilian products, but we hope that future circumstances will allow that course."

Some of the potential military uses for the synthetic rubber thread are in harnesses for parachutes, in gas masks and respirators, and in other equipment.

As now planned, the thread will be sold to textile manufacturers for military purposes in either the "naked" or uncovered form, or covered with yarn by the rubber manufacturer. "Naked" rubber thread is later covered in the textile mills. Cotton is the textile fiber most commonly used, although rayon, nylon, and silk are also employed.

Rigorous tests on the new synthetic rubber thread show 700 percent elongation, comparable to the rubber thread previously made from natural rubber compounds. Its comeback, or "kick" is comparatively the same, while its physical properties, under accelerated aging, are better.

The thread resists the effects of dyeing or bleaching much more than the natural rubber products, resists

Synthetic rubber thread has been developed, for military use only

the action of body oils carried in perspiration much better, and has greater resistance to chafing or cutting by the needles of the knitting machines. It is non-toxic and made only in black.

• • •

NYLON—A new du Pont nylon plant in Virginia, which started production in November, 1941, will be spinning by mid-summer a million miles of nylon yarn—per day!

• • •

SOYBEANS

Face a Bright Immediate Future

CHINA'S great contribution to America's victory farming, the soybean, will receive greater attention than ever during the coming crop season, according to G. G. McIlroy, director of the American Soybean Association, reports *Science Service*. Nine million acres, 54 percent more than last year, are expected to be planted to this versatile crop, which can contribute feed for the production of meat and milk, oil for explosives, paint, soap, and human food, or can be plowed under to give the soil the nitrogen which diversion of nitrates into munitions is taking out of commercial fertilizers.

Needs for handling this unprecedented soybean crop are stressed by Mr. McIlroy. We must have, first of all, available acreage. There must also be adequate machinery for cultivating, harvesting, and processing. There must be ample storage space for the beans, and for oil and cake after pressing. And finally, proper markets for oil and meal. The market for oil and meal need give no concern, at least for the duration. We are going to need all the oil for food and industrial uses that we can produce, not only as long as the war lasts but through the period of dearth that will inevitably follow it. And the same will doubtless be true for meat and milk.

FORESTS SPRAYED

To Protect Trees on Basis of their Value

SPRAYING of woodland areas has developed into something of a "big business" with a scientific background. Modern high-pressure spraying machinery and other equipment has been evolved to meet the necessity, the United States Department of Agriculture reports. This technique now has wide application in all parts of the country.

The adaptability of the autogiro for applying arsenicals over forested areas has been demonstrated and this type of equipment bids fair in time to completely supplant the use of ground machinery, say the forest entomologists. It may lower the cost of the application of insecticides to such a figure that it will be economical to protect forest lands from insect depradations on the basis of the value of the threatened timber stand rather than on the additional threat of spread to and destruction of forests in other areas.

WALL PANELS

In Colors, To be Cemented in Place

PLASTIC-COATED wall panels which are completely pre-finished and require no "on-the-job" treatment after installation are a development urged to speed up emergency housing con-

Three types of new wall paneling

struction and remodeling. Supplied in sheets as large as four by eight feet, the pre-finished boards are a product of Barclay Manufacturing Company.

Designed for either new structures or for speedy modernizing by covering old walls and ceilings, the sheets are best applied by a water-proof adhesive, but may also be installed with brads. They are available in 10 colors which are permanently bonded to the sheets by heat treatment. The surface is water-proof, stain-proof, dirt proof, vermin proof, and may be cleaned with soap and water.

Available in three types—Tileboard, Panelboard, and Streamlined Board—the sheets may be installed by any competent carpenter. Besides the more obvious applications in bathrooms and kitchens, the plastic-coated panels are also recommended for playrooms, nurseries, closets, laundries, service stations, barber and beauty shops, meat markets, bakeries, restaurants, hospitals, boats, and trailers.

• • •

VEHICLES—The rise of the motor vehicle as an instrument of government is revealed in figures of the United States Public Roads Administration, which show that while private motor vehicle ownership in the United States has risen 20 percent in the past decade, the number of vehicles owned and operated by federal, state, and local governments has risen 146 percent.

• • •

SUGAR BEETS

Improved Seed, New Labor-Saving Devices

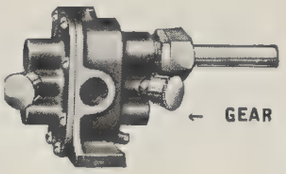
Two tedious hand processes have kept sugar-beet growers dependent on field workers. Nature's generosity in packing each beet seed with the germs of several plants has meant hours of back-breaking labor down the long rows, thinning the clumps of new beets by hand until those remaining could have space to grow and be healthy. Right now, when we need it most, comes "singled" seed. A machine developed at the University of California breaks the beet seed into segments, each containing the germ of but one plant. Planters are easily adapted for sowing the singled seed, and the small number of multiple plants can be chopped out by hoe or cultivator. One farmer cut his thinning costs in half last year by using singled seed. The seed itself is more expensive, but only one third as much, by weight, need be planted.

The second laborious hand process is the harvesting. A Colorado farmer has been tinkering for years, trying to evolve a machine for lifting beets

IMMEDIATE DELIVERY

LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS



		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	¼″	⅛″	$ 6.50	$25.00
No. 4	"	¾″	½″	13.50	32.00
No. ■	"	1¼″	1 ″	16.50	35.00

No.	1½ Gear	⅛″	Price	$ 9.00	With A.C. motor $25.00
No.	2 "	¼″	"	10.00	" " " 27.50
No.	3 "	⅜″	"	11.50	" " " 28.50
No.	4 "	½″	"	12.50	" " " 32.00
No.	7 "	¾″	"	15.00	" " " 37.50
No.	9 "	1 ″	"	16.50	" " " 49.50
No.	11 "	1¼″	"	48.50	" " " on request

HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

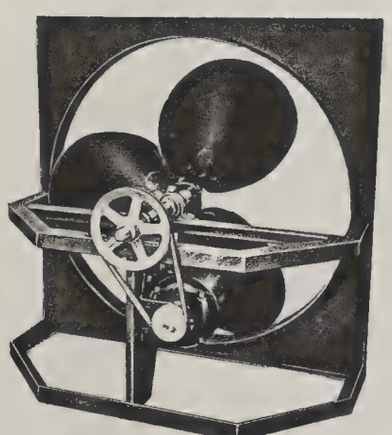
Models S H G ¼

12″ ■ 24″ tank A.C. 110 or 220 v. 60 cycle $57.50

16″ ■ 30″ tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

ATTIC AND INDUSTRIAL FANS

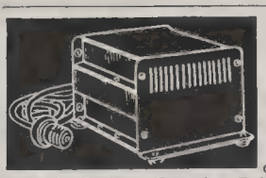


Belt driven, slow speed, exceptionally quiet in operation, highly efficient. G. E. Motors.

SIZE	H.P.	R.P.M.	C.F.M.	PRICE
24″	1/6	660	4200	$45.00
30″	1/6	540	5800	52.00
36″	1/4	415	8000	57.50
42″	1/3	390	11500	69.50
48″	1/2	360	16500	92.50

MAGNETIC GAS VALVES

All sizes in stock; Prices on request



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An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC. Only 10 watts. $9.50

"BUSH" CONDENSERS TINNED COPPER

Designed for refrigeration and air conditioning. Has many other uses. High heat transfer capacity and great efficiency.

Sizes 7¾ x 12½..... $3.25 each

Sizes 9¾ x 11¾..... 3.50 "

Limited number of larger sizes on hand.

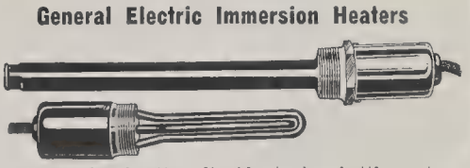
EXHAUST FANS, BUCKET BLADES

General Electric A.C. 110 volt motors.

	R.P.M.	cu. ft. per min.	Price
9″	1550	550	$12.00
10″	1500	550	13.50
12″	1750	800	18.00
16″	1750	1800	21.00
16″	1140	1650	27.50
18″	1750	2500	22.50
18″	1140	2100	32.00
20″	1140	2800	36.00
24″	1140	4000	42.00
24″	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½″ iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt.....$7 50 1200 Watt $10.50

750 " ..... 7.50 2000 " 12.50

3000 Watt $15.00

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4½″	3¾″	$22.00
0½	⅛	1750	350	6½″	3¾″	25.00
1	1/6	1750	535	6 ″	4½″	30.00
1¼	¼	1750	950	7½″	6 ″	37.50
1½	½	1750	1900	9½″	7 ″	75.00

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Weighs up to 100 grams
Compact—No loose parts
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Small convenient size
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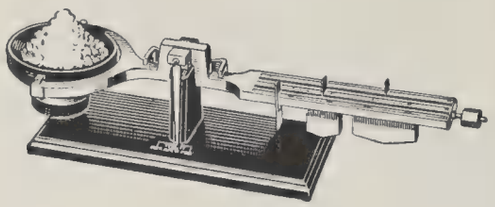

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out of the ground and topping them. He has achieved it at last and a farm-implement manufacturer has refined his crude design. Now a machine marches down the rows where before men stooped and pulled, shook the dirt from the fibrous roots, cut off the tops, and stooped and pulled the next. Another single-row topper-lifter has been developed at the University of California, and in that state of vast farming operations there are already several multiple-row machines in use.

These thinning and harvesting problems pre-suppose good seeds. Again the timing has been right. Government agricultural experts have long been at work improving the seed strains, so that now the yield is better by three tons per acre than formerly. Resistance to the curly-top disease that menaced all beets west of the Rockies, where nearly one third of the nation's crop is grown, has been successfully developed also.

The sugar beet growers have been called upon to produce well over one third of the 5,300,000 tons of sugar which Leon Henderson has designated for civilian use during 1942. Anticipated contributions from other sources are: 500,000 tons from Southern cane, 600,000 from Hawaii, 1,100,000 tons from Puerto Rico, and an equal amount from Cuba and others. Our Allies and war materials will get the remainder of Cuba's output.

OIL PROOF

Aprons and Gloves

Find Many Uses

DEVELOPED expressly to prevent dermatitis, folliculitis, and other occupational skin diseases prevalent in many industries is a new line of oil-proof and solvent-proof gloves and aprons recently announced by Resistoflex Corporation. The gloves and aprons are made of an extremely tough, flexible material with high resistance to tearing and abrasion, and the aprons are supplied in both a transparent type and a heavy-duty type employing a flexible fabric coated on both sides with a sturdy film of the same material.

According to the manufacturer, these gloves and aprons are immune to all organic solvents, including aliphatic, aromatic, and chlorinated hydrocarbons, and even to that highly active inorganic solvent, carbon disulfide. The gloves are said to be successfully used in dry-cleaning and degreasing operations where protection is needed against carbon tetrachloride, trichlorethylene, perchlorethylene, benzol, or petroleum solvents, and in magnaflux operations where they are

Protection for work and worker

unaffected by kerosene, varsol, and so on. Because the gloves contain no sulfur, they do not tarnish highly polished metal surfaces and are recommended for inspection of ball bearings, aircraft parts, and the like.

Although the gloves are not as pliable as rubber or synthetic rubber gloves, they are sufficiently flexible to afford unrestricted movement of the fingers, and because of their immunity to the above mentioned solvents they do not require repeated washing with soap and water.

• • •

SPEED—Close teamwork between American steel makers and truck and plane transportation recently enabled a British factory manufacturing tank bearings to receive a shipment of especially treated steel within four days. The steel ingots were made in the midwest and rolled into rods which were then shipped overnight by express truck to a wire-drawing concern in New England and drawn into wire. A second express truck then rushed the wire to another manufacturing plant for heat treating to specification. A plane then rushed the wire to the English plant ahead of schedule.

• • •

INSULATION

For Buildings Offers New Cotton Use

About 25 times as much cotton insulation will be used this year as last —12 million pounds compared with half a million pounds—the United States Department of Agriculture estimates. The Agricultural Marketing Administration says that the new insulating material will go into defense housing and other buildings and into refrigerator cars, trucks, and other transportation outlets. In 1941 the Department actively promoted demonstrations of the new cotton insulation, and the increase in demand is regarded as a result of satisfactory experience in the early test.

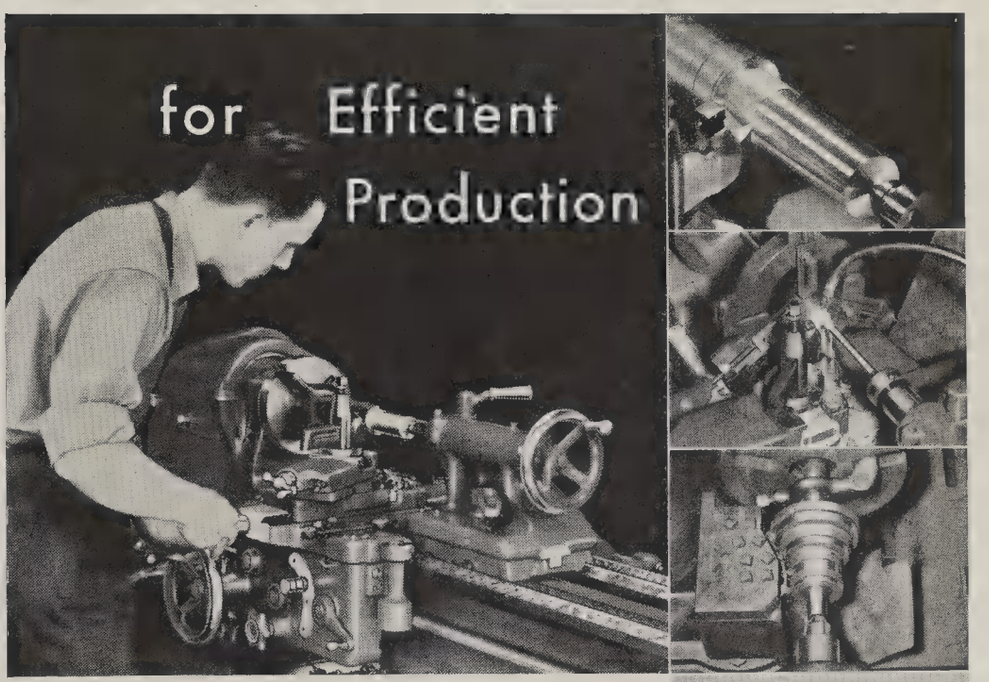
This new building material offers one promising outlet for part of the anticipated large carryover of lower grade short-staple cotton. High grade long-staple cotton is urgently needed for military purposes, and cotton farmers have been asked to plant plenty. But, as Secretary Wickard recently pointed out, an estimated three fifths of the cotton now produced is short staple, that is, one inch and shorter. Some of this is used for coarse fabrics, but much of it would be more serviceable in cotton insulation.

Use of cotton insulation, says the Agricultural Marketing Administration, is not restricted by priorities, and much of it is already going into defense housing. Private individuals who are building or improving homes are not barred from using cotton insulation. It is easily installed in new houses at the time of building. It is applicable to existing dwellings in accessible parts, such as under the roof in attics, or in unplastered side walls.

CULVERTS

Of Wood, To Replace Metal

An all wood culvert, designed by The American Rolling Mill Company, is now in production and serves as one solution to the problem of building drainage structures without the use of critical materials. On war projects, where steel is required for engineering reasons, sufficiently high priorities are granted to fill the request. However, on many drainage

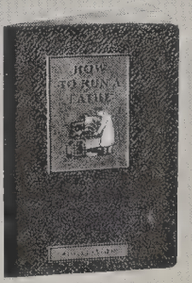


SOUTH BEND LATHES

Equally efficient on precision toolroom work or close tolerance manufacturing operations, South Bend Lathes will help solve your production problems. Substantial savings in capital investment, power consumption, floor space, and labor costs have resulted from their installation. They will give you the same efficient, trouble-free service that they are giving some of the largest war industries.

Many features contribute to the efficiency of South Bend Lathes. A wide range of spindle speeds permits maximum cutting tool efficiency. Smooth, vibration free operation permits machining work with such precision that subsequent finishing operations can often be eliminated. A convenient arrangement of controls makes for an ease of operation which reduces fatigue and lowers the probability of errors.

Made in a wide range of sizes and types, there is a South Bend Lathe that will efficiently handle almost any class of lathe work. Write for catalog and name of our nearest dealer.



"HOW TO RUN A LATHE"

A practical reference book on the operation and care of metal working lathes. Widely used for training apprentices, new operators and students. Contains 128 pages, 5⅛" × 8", over 365 illustrations. Price 25 cents, postpaid.

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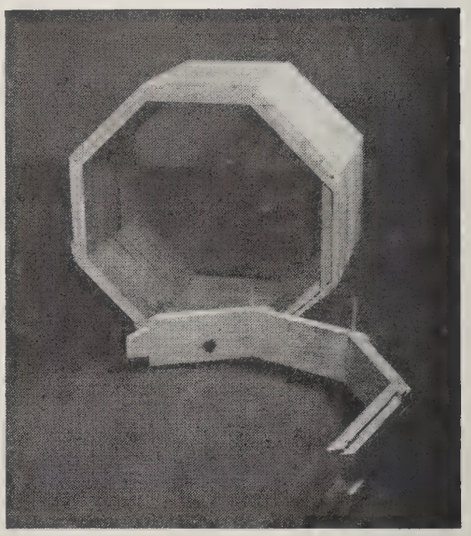
BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

operations there is a definite need for substitutes. For such purposes the wood culvert was developed.

In the case of army camps and cantonments, the wood culvert will serve the expected life of the projects. Where the culvert is used in a permanent installation, post-war replacement can readily be made either by threading a conventional corrugated metal pipe through the wood culvert, or by packing a metal pipe around it.



Designed for the duration

But replacement with steel is for the tomorrow of peacetime. Right now the wood culvert is filling the need of the present.

Because the culvert's construction employs very short lengths of wood, sizes which ordinarily would be discarded may be used to make the wooden drainage product. The only field work required is to join standard sections into any desired length, and skilled labor is not needed. Prefabricated, the culvert is light, easy to handle and to transport and assemble at the scene of operations.

• • •

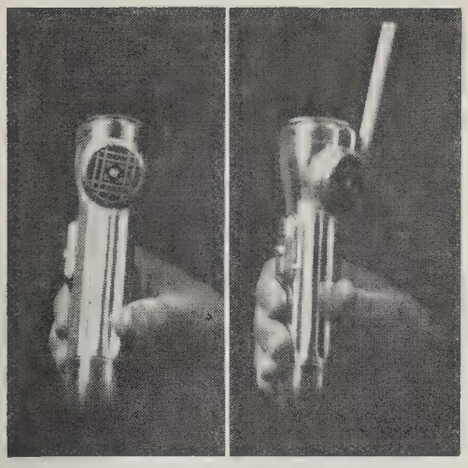
VITAMINS—Variance in Vitamin A content of each shark liver is due to several factors —grounds where the sharks have been feeding, grounds where they are caught, the season of the year. Also, male sharks have a much higher vitamin content than female.

• • •

FLASH-RULE

Combination Has Many Uses

A HANDY combination of flashlight and six-foot steel rule, illustrated in one of our photographs, was originally developed by Giffords, Inc., for use by fuel-oil delivery men who must measure oil tank levels in dark cellars. The combination had been found adaptable to other uses as well and



Light, tape measure, sling

hence has been made available for general distribution to the public.

Another feature of the combination is that the steel tape can be pulled out and slipped into a slot at the pointed end of the flashlight, thus forming a loop or sling by means of which the flashlight can be suspended around the neck, hung from the shoulder, or hooked around a pipe or beam to direct light conveniently.

QUICK-DRYING

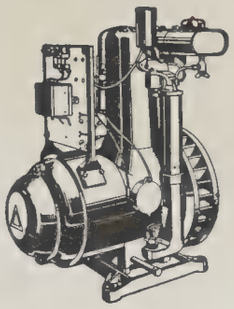
Paints Produced from Domestic Materials

Two new oils have been developed which will make it possible for the paint industry to continue the manufacture of quick-drying paints and varnishes. With imports of tung oil cut off by war in the Far East, the industry, it was feared, would soon be forced to return to the manufacture of slow-drying paints. The new developments, however, will make such a move unnecessary. It is even felt that they may permanently replace China-wood oil in this country.

Developed by Spencer Kelloff & Sons, the new oils are known as Kellin and Kellsoy. Basically they are made from linseed oil and soybean oil to which quick, hard-drying qualities have been imparted by a secret process. Commercial production is getting under way, and the company plans to increase output substantially.

Most of the principal raw materials, flaxseed and soybeans, are grown in large quantities in this country. More than 50 percent of all the flaxseed used in this country is domestically grown, with the balance imported from Argentina. All of the soybeans consumed in the United States are grown here. A satisfactory hard-drying oil has been made from castor oil by chemical reconstruction of its composition. However, the raw material, castor bean, has to be imported from Brazil.—*Chemical and Engineering News.*

Lighting Plants, New



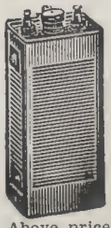
Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.

EDISON STORAGE BATTERIES

Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.



A-4	Amp. Hrs. 150	Ea.	$6.00
A-6	Amp. Hrs. 225	Ea.	6.00
A-7	Amp. Hrs. 262	Ea.	7.00
A-8	Amp. Hrs. 300	Ea.	7.00
B-2(J-3)	Amp. Hrs. 37	Ea.	5.50
M-8	Amp. Hrs. 11	Ea.	2.00
L-20	Amp. Hrs. 13	Ea.	2.50
L-40	Amp. Hrs. 25	Pr.	4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

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Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells..... $5.95

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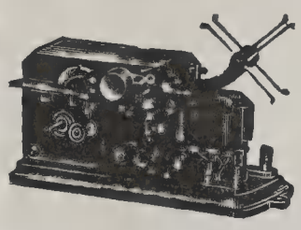

Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. Double pen permits simultaneous recording of two messages. Pens operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms. Rebuilt & finished,

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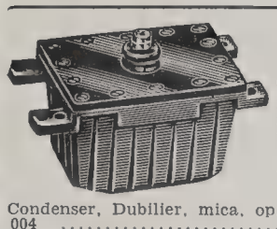

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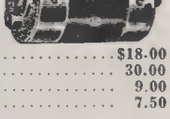

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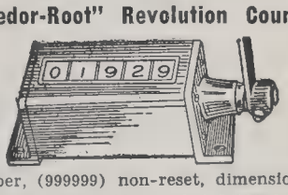

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Cargo Planes of the Future

Special Equipment Will be Needed for this Branch of Air Transportation When it Starts its Growth

ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

SEVERAL airlines this year so far have received revenues of over half a million dollars from transportation of express and freight, and mail cargo revenues over a number of lines total several million dollars annually. Yet commercial transportation of cargo by air in the United States is still in its very early stages.

So far no really special equipment for cargo work has been available. Therefore a paper by Charles P. Graddick, of United Air Lines, presented at the Annual Meeting of the Institute of the Aeronautical Sciences, which discusses operating requirements for air cargo equipment, is very welcome.

Not only must we have special aircraft, according to Mr. Graddick, but other facilities will be required as well. For example, in some of the largest cities special cargo airports should be constructed and at most ordinary airports space should be provided for freight warehouse facilities. Warehouses will be needed for temporary storage of goods awaiting transfer from one airline to another. Space will be needed for railway express agencies and for freight forwarders. Our ordinary hangars may have to be modified to include movable platforms, storage space, hoists, derricks, tractors, and so on. The general ground handling of goods must be given far greater thought than hitherto.

What will be air cargo schedules? There will be, Mr. Graddick says, air cargo ships operating on regular transcontinental cargo schedules between large centers of population. There will also, of course, be feeder planes and feeder routes.

What will be the cost? Undoubtedly rates will be a large factor in determining the volume of air cargo. There is a limit to what shippers can and will pay for speed. At the present time, air express rates are from four to seven times rail express rates and correspondingly higher than rail freight rates. A great effort, therefore, will be necessary to reduce ton-mile operating costs of air cargo planes. This can be attained only by intense study of the airplane, which is being conducted both by United Air Lines and by Air Cargo, Inc., the instrument of all carriers.

Speed of air cargo ships will have to be great but there will also have to be low operating cost which can be attained only by somewhat lower speeds than for passenger craft and greater simplicity of construction. It may be possible to work out movable bulkheads and folding seats which would make possible changes in seating capacity and cargo space by shifting the position of the bulkhead, folding it away into the floor. Some heating will be needed and also some refrigeration will have to be provided for fresh meat products, fruits, and so on. On certain local operations, single motor planes of special cargo carrying type might be utilized. It has even been suggested that gliders might be practical for regular day-by-day all-weather operations. The glider would bear the same relationship to the airplane that the car bears to the locomotive of a train.

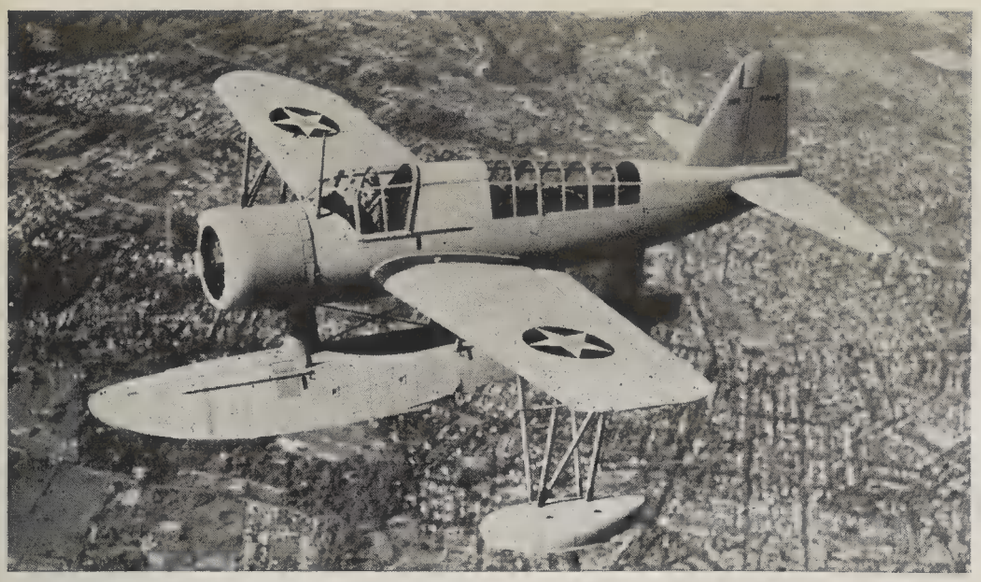
A decided advantage of cargo operation will be that it will provide a splendid training service. A pilot will have served as co-pilot in a cargo plane before advancing to Captain. Before a Captain on a cargo plane is transferred to passenger runs, he will be a well seasoned pilot who will have much more weather and flying experience than would have been possible had he gained his experience merely at school.

Mr. Graddick concludes with such factors as airports, warehouses, schedules, rates, pick up and delivery service and other factors which will have to be carefully studied before our cargo picture becomes satisfactory—yet there is no doubt in his mind that such difficulties will be readily overcome.

RAIDERS

Our Navy Comments on Fighting Planes

A GREAT deal of secrecy must, of course, shroud our aircraft operations



Like the Kingfisher, whose name it bears, the OS2U preys on underwater lurkers

against the Japanese and it is only rarely that the Navy lifts the veil a little and praise is given to the factories which are producing fighting American aircraft.

Recently, however, Secretary Knox and Rear Admiral John H. Towers have informed Douglas Aircraft Company that the "Dauntless" dive bombers and the "Devastator" torpedo planes have distinguished themselves in recent raids. They also stated that in a recent engagement between Japanese land-based aircraft and Grumman "Wildcat" carrier-based fighters a total of ten Japanese fighters and three bombers were destroyed without a single loss to our fighters.

A letter to Vought-Sikorsky said that the "Kingfisher" (OS2U), a cruiser- and battleship-based observation-scout, has been very effective in combatting the submarine menace and has also made successful attacks against the enemy.

The "Kingfisher," as can be seen from our photograph, has excellent vision, owing to the liberal use of transparent plastic material. It is a trim, mid-wing mono-powered plane with an air-cooled engine. A single main float is employed which can be readily replaced by a landing gear. — *A. K.*

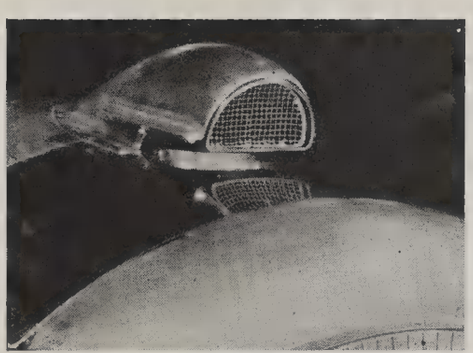
ICING

Another Airline Safety Problem Solved

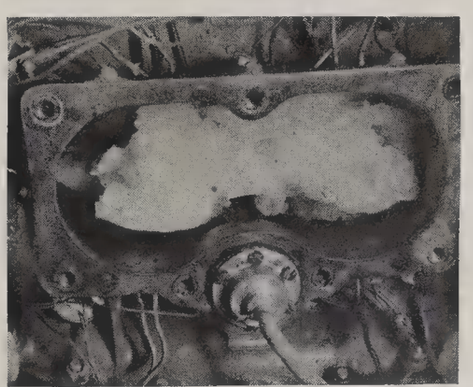
ALTHOUGH the airlines have flown more than 287 million miles during the last three years, they are still concerned about the difficult problem of icing of the carburetor intake, and it remained for Victor J. Skoglund of the United Aircraft Corporation to carry through laboratory tests in a comprehensive research into this important problem.

Special refrigerated tunnels had to be employed and a great many runs were made with scoop and carburetor subjected to high air stream and icing conditions. One of our photographs shows an assembly of carburetor air scoop and a portion of the engine cowling as it appeared before installation in the tunnel. Another picture shows ice formation practically blocking the air induction system below the carburetor — an occurrence prevalent when moist air is cooled by fuel evaporation.

As a result of his experiments, Mr.



Above: Air scoop. Below: An ice-blocked carburetor intake system



Skoglund made radical changes in the design of the air scoop; he developed a scoop with heated air valve and also a new type of fuel discharge nozzle in which the hazard from ice formation by evaporation of fuel is eliminated.

—*A. K.*

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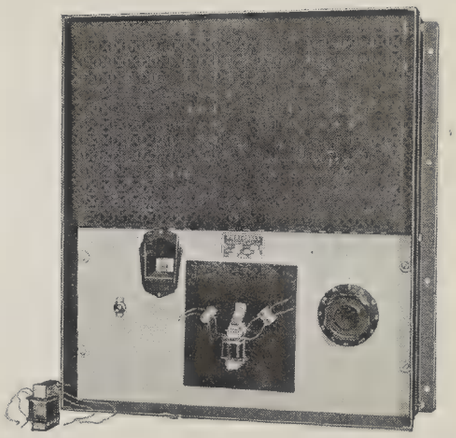
THE PRODUCT may be any electrical apparatus, parts, assemblies, which require a group of tests. Coils for telephones, relays, transformers, etc. are now being successfully tested this way.



PHOTOGRAPH shows a typical coil-inspection machine, performing 11 tests on one telephone coil.

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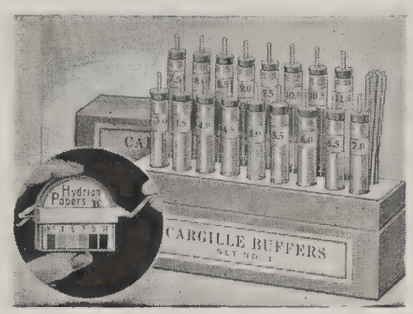
New pH Tester



Indicates These pH Values:

3.0	4.5	6.0	7.5	9.0
3.5	5.0	6.5	8.0	10.0
4.0	5.5	7.0	8.5	11.0

Buffer tablets make solutions having **pH** values indicated above. Use these on Hydrion **pH** Test Paper to match the color produced by the sample being tested. Write for circular *or send $4.50 for this complete* **pH** *outfit No. 1, postpaid, with full directions.*

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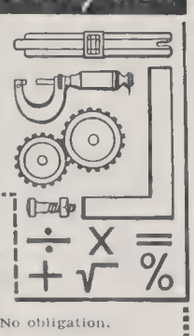

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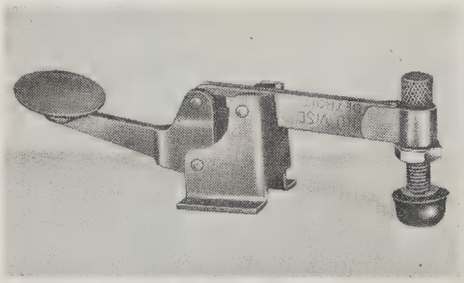
TOGGLE CLAMP

Exerts Pressure of 500 Pounds

For holding small parts when riveting, drilling, or reaming, a toggle clamp recently announced by Knu-Vise, Inc., takes the place of the many makeshift devices which are often used for these purposes.

The clamp, illustrated in one of our photographs, is screwed or bolted to a base. The screw at the holding end is



Speeds up hold-down operations

then turned down to the proper adjustment for the work in hand. By pressing on the opposite end of the clamp, a holding power of 500 pounds per square inch is applied to the rubber capped screw, the clamp automatically locking in place. Unclamping is accomplished by simply lifting up on the pressure end of the lever.

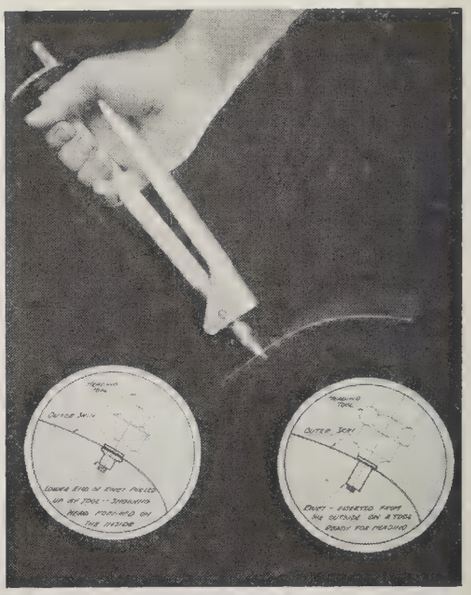
RIVET

Set Blind, Can Also Serve as Anchor

Set with a plier-type hand tool, or more rapidly with a pneumatic power tool, a new type of blind rivet, known as Rivnut, can be employed for blind rivet assembly of sheet metal or to provide a screw anchor on sheet-metal surfaces, or both.

As shown in one of our illustrations, this Rivnut, manufactured by the B. F. Goodrich Company, has a hollow shank which is threaded to provide a means for driving and also to act as a screw anchor if this is desired in the finished job.

In application, the rivet is spun on to the threaded mandrel of the applying tool. The rivet is then inserted into a hole in the sheet and the applying tool is activated. This movement



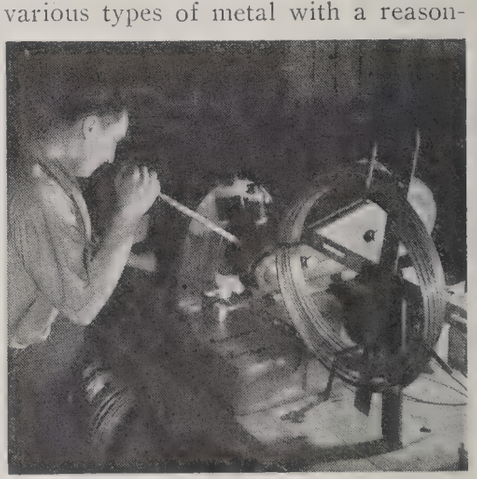
How new blind rivet is applied

pulls the mandrel of the tool back against the anvil, setting up compression in the rivet shank that causes the shank to bulge and form a ring-type head back of the sheets. The tool is then removed by backing it out of the threaded shank, the threads being unharmed in the driving operation and thus suitable for use in anchoring equipment. If anchorage is not desired, the hole can be plugged by application of a headed or headless screw.

CUT-OFF

Tool Uses Abrasive Wheel or Blade

A powerful and accurate unit has recently been made available for use where it is desired to cut lengths of various types of metal with a reason-



Cutting to precision lengths

able degree of accuracy and on a production basis. This unit, known as the Delta Cut-Off Machine, can be applied to any operations now performed by costlier machines or being done uneconomically by hand.

The unit is available in two models, with an abrasive cut-off wheel and with a special cutting blade for use on non-ferrous metals. Rapid cuts to exact lengths can be made on such materials as aluminum, brass, steel, Bakelite and all plastic materials, wire rope, brake linings, tile, hard rubber, and so on.

SANDER

Can Be Used Horizontally Or Vertically

FOR finishing operations on wood, metal, plastics, ceramics, and so on, a new floor-mounting belt sanding machine recently developed can be used in either vertical or horizontal positions.

This unit, shown in use in the horizontal position in one of our photographs, is manufactured by the Porter-

Uses standard belts

Cable Machine Company. Operated by a three-quarter horsepower enclosed motor, the belt is driven at a surface speed of 3400 feet per minute. Standard 4 inch by 45 inch dry abrasive belts or resin-bonded belts run with water or coolant may be used with this machine. The flat backing plate for the belt is four inches wide and ten inches long and the rest table is adjustable to 45 degrees.

CLEANER

Works Quickly on Sheets or Castings

A NEW cleaner for aluminum and magnesium, known as Matawan AL cleaner, is designed for cleaning either sheets or castings. Used at a concentration of four ounces per gallon at 160 degrees, Fahrenheit, it does not produce any etch or weight loss on aluminum after two hours immersion. Machined and polished magnesium shows no weight loss or etching in 15 minutes or more. At this concentration the new cleaner, developed by the Hanson-Van Winkle-Munning Company, has cleaned a mixture of equal parts of kerosene and heavy oil in 20 seconds. In a number of tests on production castings, the time required was from ½ minute to 4 minutes for thorough cleaning, depending upon the type of work and amount of shop grease present.

FILLER

For Plastics Made from Wastes

EXTENSION of the supply of certain plastics now curtailed because of scarcity of raw materials is seen in a new plastic filler material that can readily be manufactured from waste cellulose materials such as sawdust, scrap wood, cotton, or other plant fibers. Not a plastic itself, the new filler material, known as hydrolyzed lignocellulose, can be combined with synthetic resins of the phenol-formaldehyde and phenolfurfural types in proportions of three parts filler to one part resin. This gives a plastic comparable to that obtained from one part filler to one part resin when ordinary fillers are used, it is claimed. Thus it is possible during the present emergency to increase greatly the total amount of plastics which can be made from the limited supplies of phenolic resins now available. Both phenol and formaldehyde, the two most important resin raw materials, have been curtailed for ordinary use as a result of the large requirements of the munitions program.

The filler has been developed with the realization that standard procedures in the plastics industry must be adhered to as closely as possible. As a result, the techniques of compounding and molding continuously-hydrolyzed lignocellulose-filled phenolic plastics have been developed so that there is no major deviation from current practice, except for *an acceleration* of both operations—a result which is highly desirable. Particularly important is the reduction in the time required for molding cure, where a decrease by approximately one half greatly increases the productive capacity of the expensive molding machinery and thus reduces the number of units necessary for a given output.

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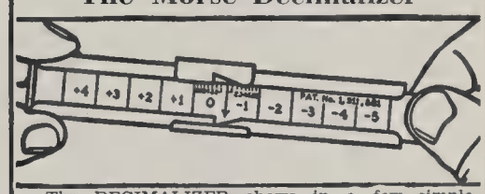

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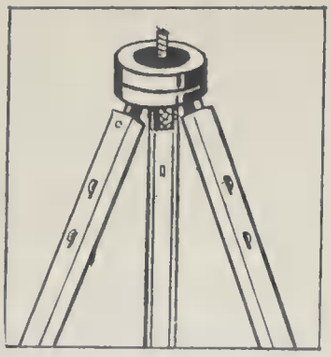

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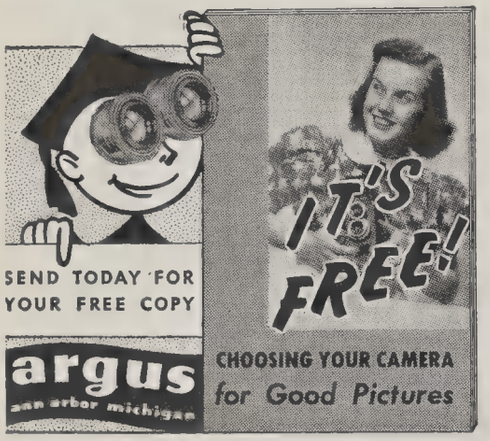

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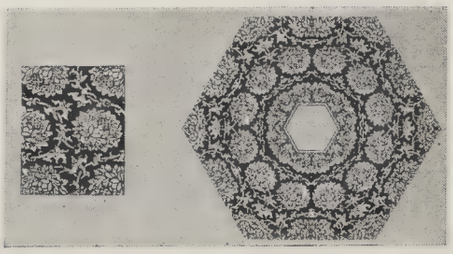
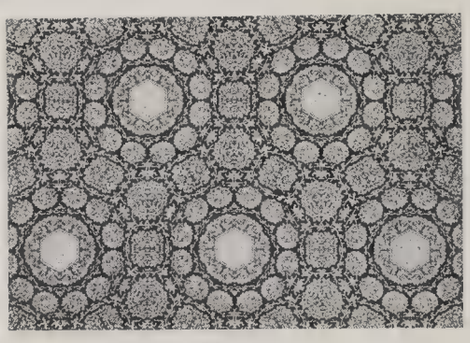
A SPECIAL camera, designed by W. H. Wallace, is so constructed that a single flat object, such as a simple drawing, a bit of lace, a trademark design, and so on, can be photographed by the camera to record five images of the same subject with one exposure. The basis of the camera, which is called the Kaleidograph, is the familiar phenomenon of two mirrors so placed that they meet at one end, forming a variable V. An object placed in the center is reflected in both mirrors; the narrower the angle formed by the mirrors, the greater the number of images, which for practical reasons is held to a maximum of five in the Kaleidograph.



Right: Original. Left: Multiple

The pattern photographed by the camera is made possible by the fact that duplication of the subject is achieved by reflections of reflections, the image being reversed each time it is reflected.

The camera itself is an ordinary 5 by 7 view outfit supplied with a special set of two mirrors so installed that they may be varied as to angle at the will of the operator, depending on the number of images desired or found feasible for a particular purpose. All the images are sharp, clear, and flat, without any noticeable distortion. Mr. Wallace uses a lens of the Dagor type, although any other lens, provided it is sharp-cutting, such as the process or Tessar lenses, may also be employed. Mr. Wallace uses Eastman Process Panchromatic film because, while full-color reproduction is not necessary in this work since the subjects are usually white, or black and white, the film is more sensitive to the red when used in artificial light and therefore permits quicker exposures than process ortho film would. This is important because very small stops must be used; even then, the exposure runs 15 to 20 seconds.



The re-photographed pattern

The object to be photographed is placed under heavy glass to make sure it stays perfectly flat during the exposure. The procedure involves three steps in all: photographing the object; pasting up the desired number of prints; and then re-photographing the pasteup.

Mr. Wallace says only line drawings and similar subjects are suitable. The camera can be used for halftone subjects as well as three-dimensional material, but the results are of doubtful value, according to Mr. Wallace.

Flashing a Crowd

WHAT would you do if you had to photograph a huge crowd assembled in a large square at night? Well, you wouldn't. Neither would we. But when you have to and it's your bread and butter, you find a way. That's what happened in the case of Pringle & Booth, Ltd., of Toronto, Canada, when they were assigned to photograph a crowd "estimated at over 60,000."

"Three 8 by 10 view cameras, loaded with Afga Superpan Press film, were set up side by side, with their Goerz 8½-inch lenses stopped down to *f*/16," they write. "The open-flash-shut exposure method was used, with 40 G.E. Mazda No. 75 photo-flash lamps in special reflectors. These were fired by dry cell batteries. We estimate the amounts of light at approximately 400 c.p. per square foot, or 750,000,000 lumens."

Baby Arrives!

THE amateur photographer does not exist who has not racked his brain on the arrival of the newborn to think up an original gag to announce the fact to the world—photographically. The results are not always happy ones—to the recipients, at any rate—though the sender's enthusiasm and genuine sentiment is fully appreciated. Once in a while, however, a really good idea comes through, an example of which is a card we received the other day from Maurice Lehv,

Posing pins

in which the father arranged a table-top affair showing a milk bottle and woolen booties, with the announcement, "Michael is Here!!" followed by the name of his wife and himself, all neatly spelled out in safety pins!

Prints Direct from Kodachrome

BLACK-AND-WHITE enlargements or contact prints from Kodachromes, lantern slides, and other positive transparencies, can now be made directly on Kodak Autopositive Paper. Available in two sizes, 3¼ by 4½ inches and 5 by 7 inches, the paper is a direct reversal medium producing a positive print from the positive transparency, automatically eliminating the intermediate negative. The paper is orthochromatic and must therefore be handled under a Series I Safelight. Claimed for it are ample speed, a rich black tone, and a simple method of processing very similar to that used in making ordinary black-and-white prints, though the borders are black instead of the familiar white. These, however, can be made white by masking the image and flashing the borders before the print is processed.

Retouching Medium

INTRODUCED by Willoughby's as the latest and reportedly one of the simplest methods available for spotting and retouching, Spotone is described as a "combination spotting, tone-building, and retouching medium developed on the stain principle." Blue-black, sepia, and natural black—the three colors supplied—may be intermixed in various proportions "to produce the greatest number of retouching colors to match the largest variety of print emulsions." Spotone may be used for paper negatives and film negatives, producing grainless tone values on the latter.

Prize Winner Tells All

WANT to know how prizes are won? Listen, please, to what Nathaniel Field has to say about his prize-winning picture, "Topnotchers," which took first place in this year's Kalart Flash Contest, in addition to having won honors elsewhere in contests and pictorial salons. Interviewed exclusively for this department, Mr. Field said:

"'Topnotchers' was taken on Decoration Day at the Ringling Brothers, Barnum & Bailey Circus grounds in Newark, New Jersey. The day was exceptionally bright, with brilliant sunshine and crystal blue skies, without a sign of a cloud. I was able to obtain the co-operation of the performers, Mr. and Mrs. Hubert Castle, in a rehearsal of their act, which was performed outdoors for me.

"In planning the composition of this picture, I decided that for two reasons a low angle would be most effective:

"1. From a low angle the picture would be more impressive.

"2. Since the background was made up of circus tents and wagons, including them in the picture would create a distraction from the principal subject. However, by taking this picture from a very low angle, all of the distracting background could be eliminated.

"Topnotchers"

"To give dramatic quality, a red filter was used to darken the blue sky. For added punch, I used a Wabash Press 40 bulb in a Kalart synchronizer at the camera, with an exposure setting of *f*/5.6, 1/500 of a second. With this exposure, it was possible to get the performers at the top of their act without sacrificing the dramatic quality desired. The camera was an Automatic Rolleiflex, the film Eastman Super XX developed in DK-20. The print was made on Velour Black paper, developed in D-72, and toned with Tuma toner to give the print a richer quality."

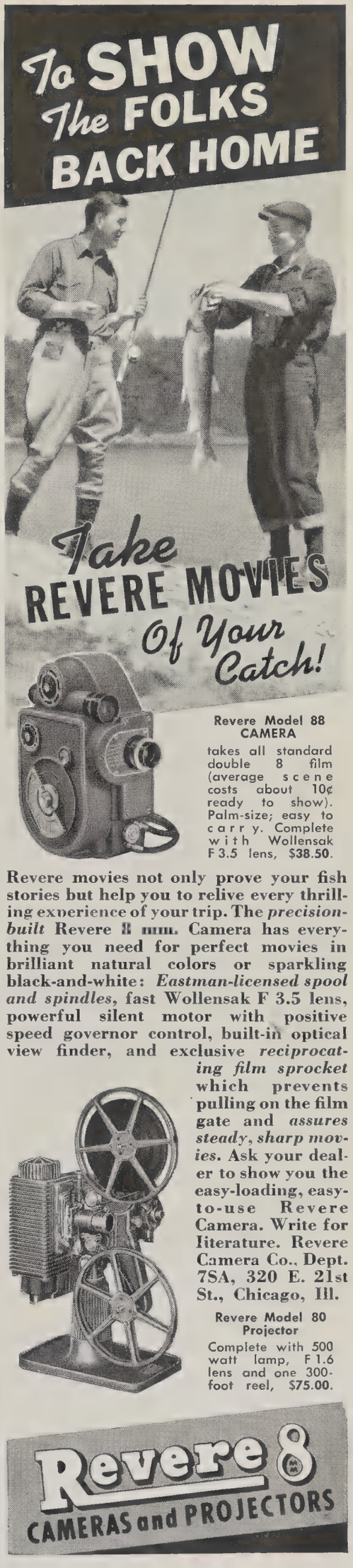
Deferment for Trainees

THE School of Modern Photography, New York City, advises that, due to the need for military photographers, draft boards throughout the metropolitan area are deferring selective service draftees until they can finish their courses at photographic schools. Fifteen men have had their army induction dates postponed from two weeks to as long as six months, they report, to give the students an opportunity to graduate from the school. The Navy, they add, is doing the same.

Kodacolor With Flash

YES, you can use flash with Kodacolor. A bulletin, No. 301, just issued by Wabash, says so. It lists data and exposure tables on the flashing of Kodacolor with one bulb mounted at the camera, or two bulbs flashed in tandem. However, you must use only the daylight blue flash, as this has the higher 6000-degree Kelvin temperature that comes nearest the required lighting conditions of bright summer sunshine.

While on Kodacolor, we hear that Eastman has published a Kodacolor Exposure Guide as the newest guide in its series of Kodak Handy Pocket Exposure Calculators. It gives full data for finding correct exposure with Kodacolor under various daylight conditions.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By E. F. McDonald, Jr.

AN EXCELLENT over-all case for gliding as a basis upon which to build a truly air-minded nation which, in turn, can create an all-powerful air-transport system and a military air force second to none. Filled with an unbounded faith in American youth, the author would train these youngsters, from the early 'teens, to get the feel of the air through safe, relatively inexpensive instruction in gliders and sailplanes. From first-hand experience, Commander McDonald knows what the "ham" operators did for radio during the 1920's. He has seen these amateurs out-do the "professionals" at every turn; he has seen them accomplish the impossible, largely because they refused to be hidebound by tradition. The present generation of youngsters, he holds, can do for aviation what the "hams" have done—and are still doing—for radio. Give them the opportunity to glide, to soar with the birds, and there will be created a vast pool of sound material from which to draw the pilots and technicians of the near future. If the war lasts very long, these youngsters will be available for rapid training in the armed forces; they will have been pre-selected by their work with gliders. When peace comes, they will be as ready to further the development of air transportation as were the "hams" in the field of radio. All this and much more is forcefully developed in the pages of this book. The first three chapters, especially, give such a build-up to the sport of gliding that the reader will be completely lacking in imagination if he is not mentally carried out of his easy chair into the quiet realms of the birds. Definitely recommended reading for everyone with the least interest in aviation. (Incidentally, Major Al Williams, who as early as 1923 proposed the use of dive-bombing tactics which have since been widely used by the air forces of the world, has publicly and vigorously advocated the use of gliders for preliminary training of airmen. Commander McDonald presents Major Williams' arguments in concise form.) Covers gliding fundamentals, gliders in defense and as military weapons, a bit of history, and a glimpse of the future. Appendices deal with licenses and regulations, gliding organizations, schools and clubs, and gliders manufactured in the U.S.A. (222 pages, 5¾ by 8¾ inches, 61 photographs, drawings of manufactured gliders.)—$2.60 postpaid.—*O. D. M.*

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In a review of the book "Nostradamus Sees All," by Andre Lamont, published in this department in the May number, the statement was inadvertently made that the astrologer Nostradamus foretold World War I, Nazism and other specific recent events. The intention was to state instead that the astrologer *allegedly* foretold these events.—*Eds.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

THE SECOND MILE, by William E. Wickenden, is an eight-page reprint from *Electrical Engineering* which will serve to clarify the goal to be set before young engineers and to give a better understanding on their part of the opportunities, obligations, and ethics of engineering. It gives an enlarged professional understanding and consciousness of this unfortunately little-understood group. *Engineers' Council For Professional Development, Engineering Societies Building, 29 West 39th Street, New York, New York.—10 cents per copy, $3.00 per hundred.*

AN INTRODUCTION TO SHIPBUILDING is a 70-page text originally compiled by Bethlehem Steel Company to familiarize new shipyard workers with all phases of shipbuilding from blueprints to fitting out of crews' quarters. Its plans, its glossary of terms, and illustrative diagrams for each are now available in lively, understandable style to a ship-conscious nation through joint sponsorship of the WPB and Bethlehem Steel Company. *Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.—20 cents.*

POSSIBLE ALTERNATES FOR NICKEL, CHROMIUM AND CHROMIUM-NICKEL CONSTRUCTIONAL ALLOY STEELS is a 144-page bulletin describing four completely new series of alloy steels designed to make the nation's limited reserves of strategic metals go further and help build more materiel of war. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York.—50 cents.*

APPLE VARIETIES is a bulletin describing the important climatic and topographic features of the main apple-producing sections of the United States; insect and disease conditions; and characteristics of leading varieties. Bulletin FB1883. *Office of Information, United States Department of Agriculture, Washington, D. C.—Gratis.*

HERE'S HOW TO HANDLE IT is a 16-page illustrated bulletin describing a wide range of belt conveyors for handling bulk materials in industry and on engineering projects. Bulletin No. 410. *Chain Belt Company of Milwaukee, Milwaukee, Wisconsin.—Gratis.*

FIREPROOFING is a copy of a report presented to the American Wood Preservers Association for the benefit of engineers, architects and others interested in fireproofing methods for wood. *Mr. H. L. Dawson, 1427 Eye Street, N. W., Washington, D. C.—Gratis.*

PLATING CONVEYOR BULLETIN gives illustrations and detailed descriptions of the construction and improved features of these conveyors. It describes various types of drives, a wide range of carriers, methods of agitation and ventilation, and the operation of machines. Profusely illustrated. Request Bulletin SA-101. *Hanson-Van Winkle-Munning Company, Matawan, New Jersey.—Gratis.*

FRACTIONS, WHY THEY ARE DIFFICULT AND THE REMEDY, is a 19-page pamphlet on the octic system of numeration. *E. M. Tingley, 221 North Cuyler, Oak Park, Illinois.—Gratis.*

REPORT ON EXPERIMENTS WITH COLCHICINE BY LAYMAN SCIENTISTS, by Eigsti and Tenney, contains practical instructions for producing hereditary changes in plants by applying colchicine to the growing portions. *University of Oklahoma Press, Norman, Oklahoma.—35 cents.*

THE NEXT STEP AHEAD IN FLUORESCENT LIGHTING is a folder describing briefly the newest type of cold-cathode fluorescent tubes which start instantaneously when the switch is operated, and which have numerous advantages over the familiar fluorescent tubes which have a time lag in starting. *Fluorescent Lighting Association, 509 Fifth Avenue, New York, New York.—Gratis.*

SAFE INVESTMENTS is a file folder containing loose inserts describing various types of protection equipment for industrial plants. These range from welders' masks, aprons, and capes through hand-protecting gloves to various types of goggles and protective clothing. *Kimbal Safety Products, 7314 Wade Park Avenue, Cleveland, Ohio.—Gratis.*

WE'VE COME A LONG WAY is an elaborately produced brochure tracing the development of the American standard of life and of the part which porcelain enamels have played in this development. Partly "human interest" and partly devoted to excellent illustrations of steps in the process of manufacturing these enamels. *The Hoffman Brothers Company, Charles Street at 22nd, Baltimore, Maryland.—$1.00.*

TAYLOR INSTRUMENTS FOR PRESSURE is a 24-page bulletin illustrating and describing various types of instruments for indicating, recording, and controlling pressures in industrial operations. *Taylor Instrument Companies, Rochester, New York.—Gratis.*

WARTIME EMERGENCY FIRST AID is a single sheet describing various types of first-aid equipment for factories and offices, as well as stretchers, asbestos suits, protective helmets, and other equipment for air raid protection. *E. D. Bullard Company, 275 Eighth Street, San Francisco, California.—Gratis.*

LYCOMING AIRCRAFT ENGINES is a four-page folder presenting flight views of the numerous types of Lycoming-powered training planes as well as illustrations and brief descriptions of five types of engines ranging from 50 to 300 horsepower. *Department B, Lycoming Division, The Aviation Corporation, Williamsport, Pennsylvania.—Gratis.*

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS
Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

UNFORTUNATELY, there is no book on amateur spectroscope making — nor even an amateur's book on spectroscope using. Potential market for such a book is probably too limited to make it pay its own way (say 3000 copies sold) but this department will rejoice if any writer ever disproves this theory. Until then the amateur spectroscopist will have to do the best he can with what he has: a few technical works on spectroscopy (cited in these pages, March, 1941), and here and there a description by some amateur who made a spectroscope despite the lack of an ideal, all-around handbook.

Such an amateur is R. M. Watrous, M.D., 1924 Flora Place, Highland Park, Ill., and his account, written by request, follows:

"The concave grating spectrograph is undoubtedly the simplest of all types for the amateur to construct because it has only one optical surface, requires no collimating or objective lenses, and can be constructed to give almost any desired amount of dispersion. The essential optical part can be bought for $4.50 and up; the rest of the instrument for the most part can be made of wood and scrap brass, and does not require elaborate machining. Scientific supply houses, such as the Central Scientific Co., Chicago, list in their catalogues a variety of replica gratings made by taking collodion impressions of famous gratings ruled on glass. These are offered in three grades at three sets of prices, depending on the degree of faithfulness with which the original rulings are reproduced. The medium grade has been found to give amply good performance in the instrument to be described. Replica gratings can be obtained mounted on silvered spherical concave mirrors of various focal lengths, and one of these is the only optical part needed for a concave grating spectrograph.

"The concave grating spectrograph may have various forms, but all are dictated by the optical principle laid down by Rowland, which states that the slit, the grating, and the spectrum must all three lie on the circumference of a circle whose diameter is equal to the radius of curvature of the mirror on which the grating is mounted. The mirror and the spectrum must lie at opposite ends of one diameter of the circle, in order to have images of the slit in focus, so the only possible variations in design must be obtained by changing the location of the slit along the circumference of the circle. In practice, the parts are arranged as shown in Figure 1.

"In order to understand how images are formed by a concave grating, it is worth while to imagine the mirror on which the replica is mounted set up facing the observer as for a Foucault test, using a slit at the center of curvature as the source of light. Under such circumstances, the image of the slit will be cast back upon it, and a percentage of the light striking the mirror will be returned. However, the grating will cause some of the light to be diffracted, with the result that varicolored images of the slit will be formed both to the right and to the left of the direct image. Thus there are two first-order spectra. To the right and left of these respectively will be another set of colored images, forming the second-order spectra, and beyond these will be third-, fourth-, and *n*th-order spectra, each fainter and more spread out than the last. If the slit be now moved to one side sufficiently, and also be brought closer to the mirror, to preserve the relationships of Rowland's circle, the direct image of the slit will move in the opposite direction, as will all the spectra, until a position is reached in which the images will lie in the positions shown in the figure. By moving the slit still farther, the second-order spectrum could be brought opposite the mirror. [Detail in extension of this particular paragraph, by Dr. Watrous, may be borrowed from this department on request by readers interested in this type of spectroscope.—*Ed.*]

"Having determined the dimensions required to secure the relationship shown in the figure with any given concave grating, it is necessary only to construct a box to support the parts and exclude light, and one has a spectrograph. A film-holder may be made, to support films at the point where the spectrum comes to focus, or a telescope eyepiece may be supported at this point for direct observation. With such an instrument, clear spectrograms may be obtained 8" long, showing hundreds of details such as Fraunhofer lines. The light obtained by sparking two iron nails across the terminals of a storage battery will give a beautiful line spectrum of iron. Light passed through solutions of hemoglobin, dyes, chlorophyll, and others, will show characteristic absorption bands. Bunsen's famous experiment with the sodium flame can be performed; and so on.

"In choosing a grating, a few facts should be kept in mind. The degree of dispersion (and thus the length of the first-order spectrum) is proportional to the number of lines per inch in the grating and to the focal length of the mirror. The resolving power, however, depends on the area of the grating and the accuracy of the ruling. The spectrograph shown (Figure 2) contains a medium grade grating of about 40" radius of curvature, with 14,500 lines to the inch and a grating area of about 2 x 3 centimeters.

"The box is made of plywood, painted black inside, and with light baffles located at strategic points. The adjustable slit mechanism is on the left. The sliding adjustment for the film-holder is on the right, actuated by the two vertical screws. In Figue 2 the film-holder has been removed and is resting on top of these screws, its slide pulled two thirds of the way out to show how it is loaded. The main body of the camera extends into the background, with a small square porthole in the far end to give access to the adjustments of the grating mount. [In Figure 1 the slit is on the right of the spectrum but it matters not.—*Ed.*]

"The slit of a spectroscope is one of the essential parts, since every detail of the spectrum is actually an image of the slit. Its edges should be as smooth and as parallel as the maker's skill can con-

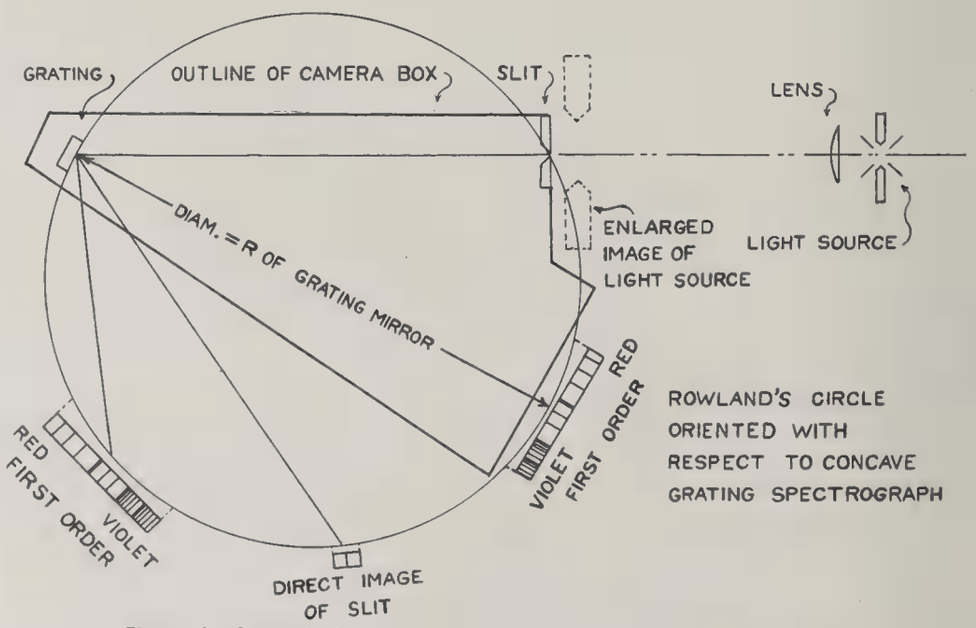

Figure 1: General plan of the concave grating type of spectrograph

trive, and one may lavish as much or as little care on it as he wishes. For ordinary work, a slit 0.002" to 0.003" in width is suitable, and there is very little actual use for an adjustable width. Provision should be made for rotating the slit mounting to line it up parallel with the ruling of the grating for best definition, and it should be mounted in a draw-tube so that its distance from the mirror can be varied slightly for focus.

"The jaws of the slit may be made of brass and should be filed to a chisel edge and then sharpened like a chisel on a flat piece of plate glass, using finishing emery. After the edge is sharp, it may be

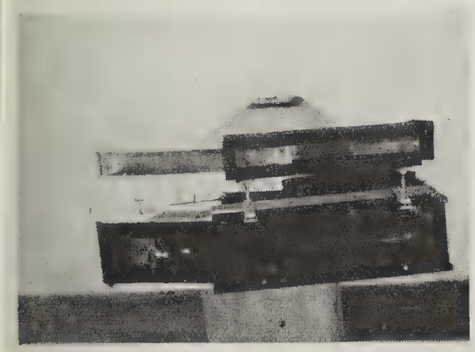

Figure 2: Watrous' instrument

placed on a very clean, smooth piece of plate glass and gently pressed down. This will smooth out the "saw" edge and give a perfectly straight line. The two jaws should then be placed in their channels and closed gently together in front of a strong light. I believe that irregularities of less than .001" can be detected with this test. The most difficult part of an adjustable slit to make is the parallel channels in which the jaws are to slide. Not having a milling machine, I built these up out of strip brass. [By using a principle to be described next month, this problem is avoided.—*Ed.*]

"Thirty-five millimeter film is very useful for making spectrographs, and a holder may readily be designed to accommodate strips long enough to take in the full length of the spectrum. The film should be held in a curve conforming to Rowland's circle. Though it adds considerably to the problems of construction, a slide which permits the film holder to be moved at right angles to the length of the spectrum in the same plane will prove well worth while, since it allows up to ten spectra to be made on one film, with all the advantages of being lined up for comparison with one another. With such an arrangement, a narrow slit-like mask should be placed just in front of the focal plane so that each spectrum occupies a strip about 2 mm wide running the length of the film.

"The grating mount, as all telescope makers will realize, must be adjustable as to tilt in two dimensions, and it must have an adjustment for rotation about the mirror axis, in order to line up the rulings in a vertical position.

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hours of study, but one must secure the co-operation of some patient soul to wield a mirror in order to direct the light into the slit, or else make a heliostat. If photographs are made, of course, they can be studied at any time.

"Carbon arcs give fine line spectra, and are excellent for collimating the instrument. Cored projection carbons, 5/16" size, will operate well on ordinary house current if the arc is placed in series with a cheap heating element or electric iron drawing about 500 watts. If the carbons are removed from this circuit and replaced by iron nails, copper wires, aluminum, brass, nickel, or lead rods, light can be produced by making and breaking the contact, which will give beautiful bright-line arc spectra of the metals. These flashes are too fleeting to study visually, but can be recorded on film and the lines can be identified with the aid of a table of wavelengths.

"If the experimenter has a small transformer, such as is used for neon signs, he can obtain spark spectra of metals by causing the spark to jump between electrodes of the proper material. In order to obtain emission of lines, however, a condenser must be placed across the secondary of the transformer. The writer found that a home-made, one-quart Leyden jar served this purpose very well, though a more efficient and less bulky condenser would be preferable.

"The light from neon signs, fluorescent lights, and sodium vapor lamps will furnish interesting material for study and will also challenge the ingenuity of the experimenter to find some way of making it enter the instrument. On one occasion I balanced my spectrograph, which is about the size and shape of a baby's coffin, across the back seat of my car, while my wife sighted it like a rifle at a sodium vapor lamp and I held a condensing lens so as to cast an image on the slit. This was on a busy highway, but fortunately the stunt took place at night!

"Figure 3 shows three contact prints made from portions of negatives obtained in the instrument. They extend from the orange to the violet. Violet is on the right.

Top: Arc and spark spectra of metals; from top to bottom: aluminum arc; 15,000-volt condensed spark between Al electrodes; iron arc; spark between iron electrodes; copper arc; copper spark; nickel arc; nickel spark; spark between platinum electrodes.

Middle: Series of exposures made with carbon arc for purpose of focusing slit.

Bottom: Absorption spectra of hemoglobin derivatives: carbon arc; next two, light from incandescent portion of carbon arc passed through hemoglobin solutions; next two, same through methemoglobin solutions; next two, same through carbon-monoxide-hemoglobin (note shifting of the two dark bands to the right); carbon arc.

"The two D lines of sodium are especially prominent in most of the negatives made with light from the carbon arc. They appear near the left margin in the middle set of spectrograms, and serve as convenient landmarks.

"Brode's 'Chemical Spectroscopy,' 1939, is a fine technical work with 120-page tables of wavelengths and other things but no information on building spectroscopes. The old maestro of the subject was Baly, whose 3-volume 'Spectroscopy' was published in 1912, but this, too, is pretty technical and is no longer in print."

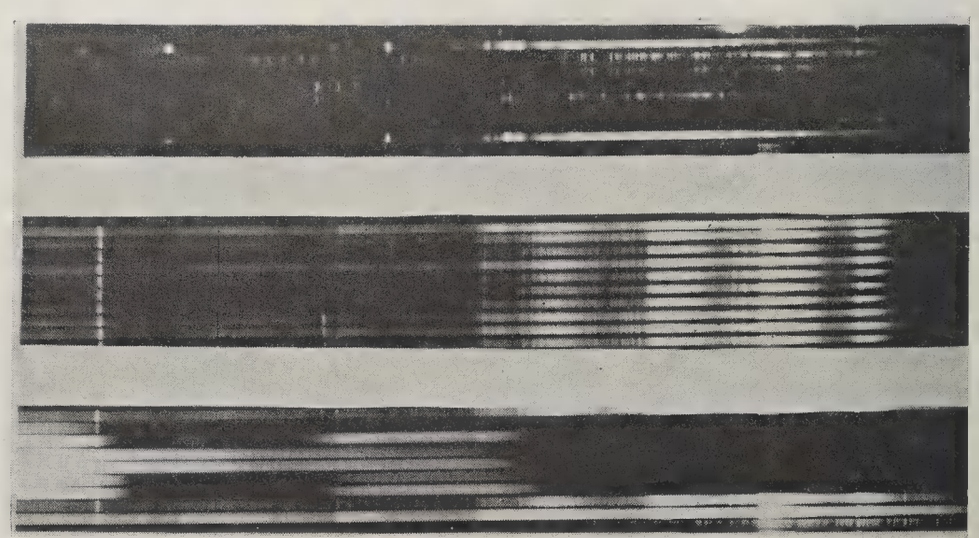

Figure 3: Spectrograms obtained with the Watrous spectrograph (see text)

NEXT month two or three shorter items on amateur spectroscopy will be presented in this department.

STELLAFANE convention of amateur astronomers and telescope makers has been called off this summer. War.

FROM Thomas Hindle, England, son of the noted amateur telescope maker, J. H. Hindle, the following cablegram has been received: "Regret inform you my father John H. Hindle, F.R.A.S., died on 17th May aged 72. He was governing director of Hindle Son and Co., Ltd., and had many engineering inventions to his credit, notably the electric baling press and electric control for wide looms." It is hoped that further detail concerning Mr. Hindle will later be made available for publication in this department.

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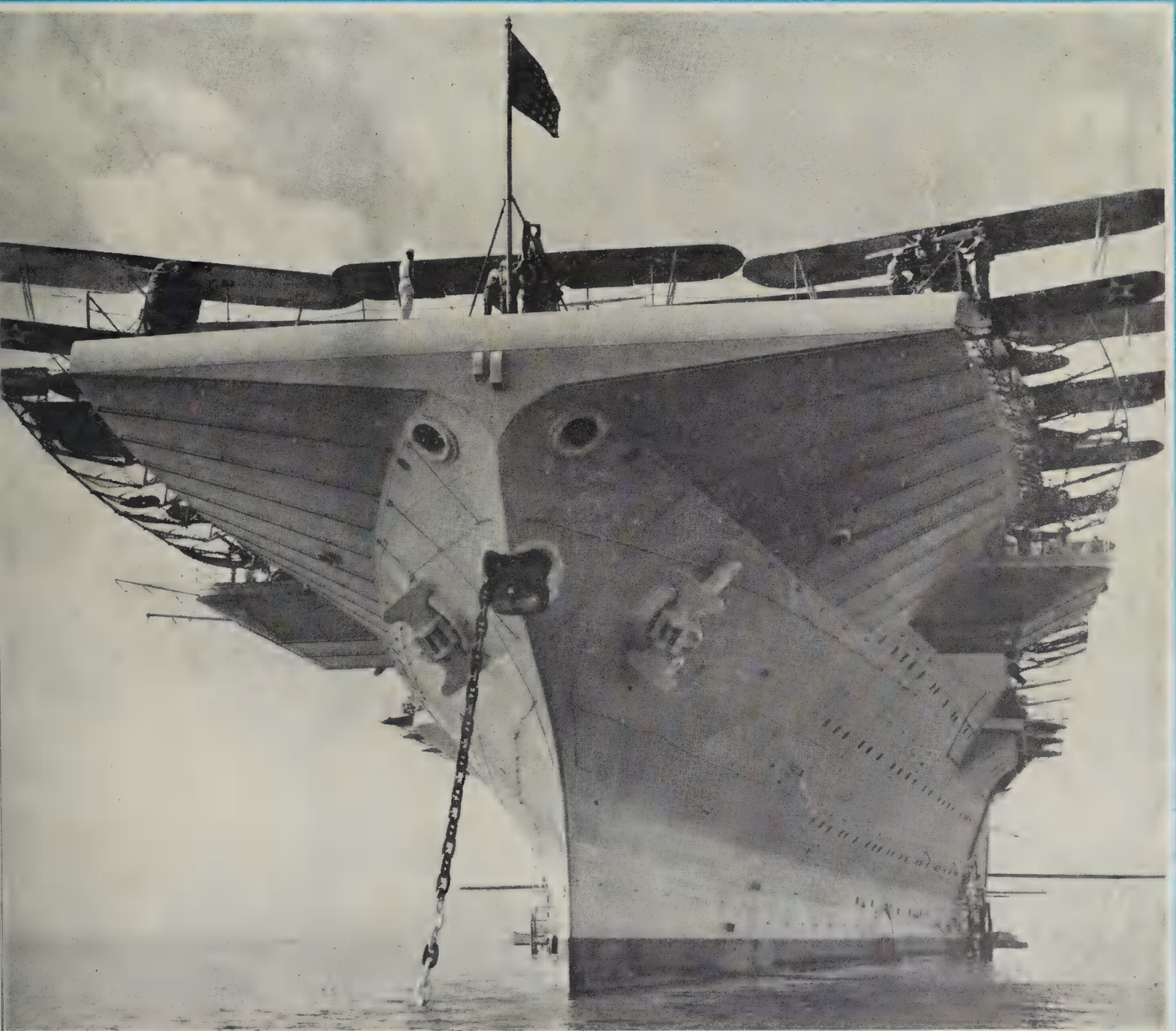

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But it's the toughest weapon these men you are looking at will ever take into battle. It's the stuff with which all our wars are won.

The boy in the uniform doesn't call it *morale*. That's a cold potatoes word for something John American feels deep and warm inside.

Perhaps he can't give it a name. But he can tell you what it's made of.

It's made of the thrill he gets when his troop train stops at a junction point and fifty good-looking girls are at the station with cigarettes.

It's made of the appreciation he feels for a bright new USO clubhouse where he and his friends can go for a few hours' rest and relaxation.

It's made of laughter and music—when Bob Hope or Lana Turner visits his camp with a USO show.

It's even made of a cup of coffee and a Yankee smile—at some lone outpost in Alaska or the Caribbean

Maybe it's just a feeling of kinship with this land of a hundred million generous people. Maybe it's just the understanding that this whole country cares; that the soldier is bone of our bone; that he and we are one.

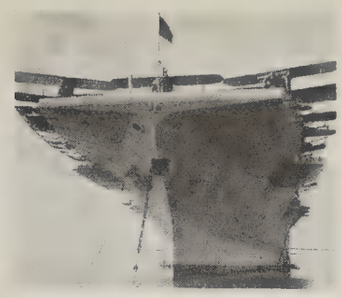
Name it if you can. But it's the secret weapon of a democratic army.

What can you do to sharpen this weapon? Give to the USO. This great national service organization has been entrusted by your government with responsibility for the service man's leisure needs.

The requirements of the USO have grown as enormously as our armed forces themselves.

Give all you can—whether it's a lot or a little. Send your contribution to your local chairman or to USO, Empire State Building, New York City.

★ USO ★



THE PLANE carrier, *U. S. S. Lexington*, damaged in the Battle of the Coral Sea, later sunk by American torpedoes to prevent possible usage by Japs, was a gallant ship, manned by a gallant, hard-fighting crew. The story of the *Lexington* and her sister plane carriers and the role they must play in this war begins on page 52 of this issue.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1892)

INVENTION—"Invention being practically synonymous with new thoughts, and thoughts being the outgrowth of knowledge, the value of knowledge to the inventor is apparent, even though it may be in the nature of obscure impressions of the memory, vague suggestions from men and things, or broad yet accurate and practical information on any subject. . . . There is certainly no limit to the amount of material available. It is only necessary for the inventor to place himself in the proper relation to existing materials to enable him to reach out and take the reward."

FALLING BODIES—"An exceedingly interesting series of experiments is now being carried on in Paris, by MM. Cailletet and Colardeau, in which they are seeking to verify the law of falling bodies and at the same time those of the resistance of the air to the passage of bodies. . . The investigators have installed their laboratory on the second landing of the Eiffel tower, which gives them a free fall of about 370 feet. . . MM. Cailletet and Colardeau have employed a very ingenious

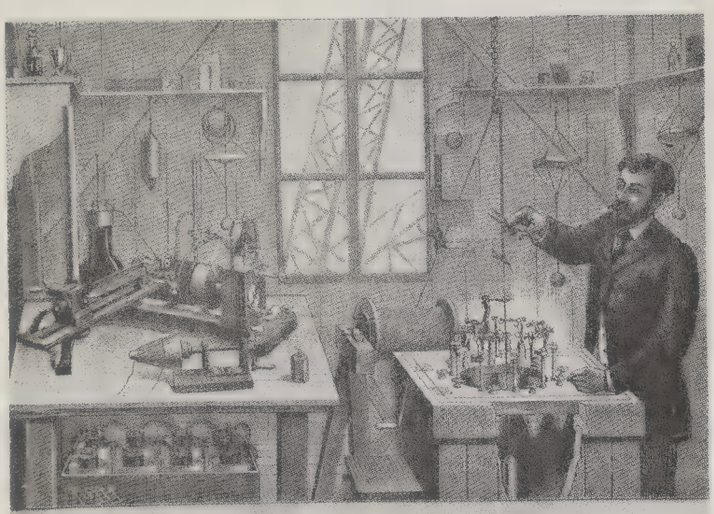


Fig. 1.—LABORATORY IN THE EIFFEL TOWER, PARIS.

electrical method of timing the fall of the variously shaped objects experimented with. . . The falling body is attached to a very fine light thread, which is divided into sections of 20 meters each. Each one of these sections is wound on a wooden cone. . . When each of the sections of 20 meters is unrolled, an electric contact actuates a registering pen upon which an electric tuning fork chronograph indicates the instant with a precision of 1-100 of a second. Thus at the end of every 20, 40, and 60 meters, etc., a time record is automatically made."

TRANSPORTATION—"The removal of horses from the street cars and the propulsion of the latter by means of electricity already has been accomplished in many of our towns and cities. The day seems to be near at hand when this marvelous agent will be still more extensively employed in connection with pleasure carriages and vehicles of all kinds. In fact, the electrical omnibus now exists in London."

TIES—"A summary of five years' experience with metallic ties on the Belgian State railroads is given by Mr. Janssen. . . . Up to the time of making the report the track with metallic ties has cost for maintenance about nineteen times as much as the track with creosoted oak ties. Beyond this, many of the metallic ties are damaged to such an extent that they must soon be removed."

BEER—"The total production of beer during the past year upon which revenue was collected amounted to 31,475,519 barrels —a net increase of 1,453,519 barrels over the production of the previous year. The average annual consumption is a little less than one half barrel for every man, woman and child in the United States."

BIRTH AND DEATH—"French science has to deal with a peculiar problem, how to prevent the depopulation of the country, which is now going on so rapidly that the deaths exceed the births by nearly 40,000 in a single year. Increasing the birth rate having proved impracticable, the present hope is to diminish the death rate. . . . It is now illegal for any person to give children under one year of age any solid food except on medical advice, and nurses are forbidden to use nursing bottles having rubber tubes. Efforts are being made also to induce Parisian mothers to nurse their own infants."

TELEPHONE—"The original patent for the electrical telephone was granted to Alexander Graham Bell, of Salem, Mass., on March 7, 1876, for the term of seventeen years. The patent expires March 7, 1893. . . . The expiration of the telephone patent throws open to the public a new invention of incalculable value to the country. Its future development and expansion must necessarily give rise to many collateral new industries, furnishing wealth and employment for thousands of busy workers."

WATER-WEIGHTED—"A novel form of inclined railway has been built at Bridgenorth, England. . . . There are two cars, on separate lines of rail, and they are connected by a steel cable passing round a wheel at the top. They are thus balanced, and a preponderating weight is given whichever one is at the top, by pumping a supply of water into a tank placed in the frame of the car."

IRONCLAD—"The French ironclad Le Hoche has just given the world an object lesson in the use of the ram. On July 7, the French squadron at Marseilles was exercising, and the ironclad was crossing the roadstead at full speed, when it struck the mail steamer Marechal Canrobert (1,200 tons), then coming in from Italy, hitting her fair and full. The shock was tremendous, and the captain of the ironclad, foreseeing the consequences, ordered the steamer to be secured to his own vessel, and the passengers transferred. The fastening hawsers were then cut, twelve minutes after the collision, and the steamer instantly sank, the blow having cut her nearly in two. The ironclad remained uninjured."

POWDER—"On July 2, on the invitation of the directors of the Smokeless Powder Company, a number of gentlemen interested in military matters witnessed an exhaustive trial of the qualities of the explosives manufactured by the company. . . Five men, having the spectators at the 400 yards firing point, fired rifle volleys at 300 yards and at 200 yards, the result being that no substantial wreaths of smoke were visible. Finally, 500 shots were fired with the powder from the Maxim gun, with the result that there was very little smoke to be seen, although ten shots with black powder made an opaque cloud."

Be Calm Courteous Effective

Right now, when times are tense and everybody is under strain, "The Voice with a Smile" is more important than ever.

We've all got a big job to do and the friendly, effective use of the telephone helps every one do it faster and better.

The calm way is usually the competent way. Being courteous usually means saving time and tempers all along the line.

BELL TELEPHONE SYSTEM

"THE TELEPHONE HOUR"— *presenting great artists every Monday evening — N. B. C. Red Network.*

98TH YEAR SCIENTIFIC AMERICAN AUGUST 1942

SEA NESTS FOR WAR BIRDS

Modern Warfare is Proving the Value of Aircraft Carriers

WALTON L. ROBINSON

● Second of a series of analytical articles on the United States Navy, the first of which, dealing with battleships, appeared in our issue of May, 1942. Other articles will be published when and as released for publication by the Navy Department. — The Editor. ●

NEXT to battleships, aircraft carriers are the largest and most costly type of naval vessel. Despite their huge size they are not, however, combatant ships in the strict sense of the term. Although several have rather heavy armaments and fairly good protection against medium-caliber shells, they are not intended to engage enemy ships in battle. Their guns are purely for defensive purposes: to beat off hostile aircraft or warships which penetrate their protective screen of fighter planes and destroyers. Their offensive strength is entirely concentrated in the squadrons of bombers and torpedo planes which they accommodate in their enormous hangars and which can quickly be put into the air from their broad flight decks.

Relatively new and untried on the outbreak of the present war, aircraft carriers have since demonstrated their great value and are now indispensable adjuncts of every large and well-balanced navy except the Italian. When operating directly with the fleet they are generally stationed about 100 miles to the rear of the battleship line. In this position they are reasonably safe from the enemy's cruisers and destroyers, although still offering an inviting and highly vulnerable target to his aircraft. A few bombs landed on the flight deck would render that particular carrier useless for the remainder of the action.

Carrier-based aircraft have won four major successes: Taranto, Cape Matapan, destruction of the *Bismarck*, and Pearl Harbor. In this last operation three or four Japanese carriers brought about 150 bombing and torpedo planes to within at least 500 miles of our great Pacific base. In successive attacks lasting all day these aircraft sank the battleship *Arizona*, destroyers *Cassin* and *Downes*, minelayer *Oglala*, and target ship *Utah*; gravely damaged several other heavy and light warships, including the battleship *Oklahoma*, which capsized; and destroyed a large number of Army planes, most of them on the ground. Defending forces shot down about 40 of the attacking planes.

The United States Navy is fairly well provided with aircraft carriers. Last December we had seven regular carriers in service and eleven others under construction or on order. Several large merchant ships, taken over by the Navy, had been or were being converted into auxiliary carriers. Two of these ships were the U.S.S. *Long Island* and U.S.S. *Kitty Hawk*. Our seven regular carriers displaced around 155,000 tons and normally operated about 575 fighting, bombing, scouting, and torpedo planes. Japan's carrier force, exclusive of a number of converted merchant ships, consisted of at least 11 units. They were, however, much smaller and slower than their American counterparts. They displaced about 173,000 tons and accommodated only about 500 planes. But that the Japanese know how to employ their carriers was amply shown at Pearl Harbor and in more recent operations in the Southwestern Pacific.

America's aircraft carriers range in size from the 14,500-ton *Ranger* to the 33,000-ton *Saratoga* and *Lexington*, largest ships of their kind in the world. The eleven under construction or on order will be ships of about 25,000 tons. Three of them are scheduled for completion next year, three the following year, four in 1945, and one in 1946. Planes and carriers to match Japan's present overwhelming air superiority in the Far East are our Navy's greatest needs today.

Our oldest carriers are the giant *Saratoga* and *Lexington*, launched in 1925 and completed in 1927 at a cost of about $45,000,000 each. They were originally authorized in 1916 as units of a class of 35,300-ton battle cruisers armed with eight 16-inch guns. After the war, but before construction had begun, their design was altered and displacement increased to 43,500 tons. The *Saratoga* (Battle Cruiser No. 3) was laid down September 25, 1920, by the New York Shipbuilding Company and the *Lexington* (Battle Cruiser No. 1) January 8, 1921, by the Fore River Shipbuilding Company (now the Bethlehem Steel Company). Work on them and their sister-ships *Constellation*, *Ranger*, *Constitution*, and *United States* had not progressed very far, however, when early in 1922 the Washington Naval Treaty put a stop to further competitive building of capital ships by the world's five principal sea powers. In accordance with the terms of this treaty Congress on July 1, 1922, authorized the conversion of the *Saratoga* and *Lexington* into aircraft carriers. Their four sister-ships were broken up on the building ways in compliance with the same treaty. The scrapping of these fine ships and of seven powerful dreadnoughts, not to mention that of 20 older battleships in service, was America's magnificent but futile contribution to the ideal of disarmament and world peace.

THE *Saratoga* and *Lexington* have a standard displacement of 33,000 tons; fully loaded they displace over 40,000 tons. Their length on the waterline is 830 feet and their over-all

U. S. Navy Official Photo

Navy planes warming up on the deck of a carrier, preparatory to the take-off

length, which includes the overhang at bow and stern, 888 feet, making them the longest warships ever built. An extreme beam of 105½ feet barely enables them to squeeze through the Panama Canal locks. At full load they draw 32 feet of water.

These two carriers mount what in reality is the most formidable armament ever provided in ships of their class. They carry eight 8-inch guns, twelve 5-inch anti-aircraft guns, and numerous smaller weapons. Their 8-inch guns are 55 calibers in length (that is, 36 feet, 8 inches), elevate to 30 degrees, and hurl a 250-pound shell at a maximum range of some 28,000 yards or about 16 miles. They are mounted in pairs in four armored gunhouses along the starboard side of the flight deck, where they enjoy an exceptionally wide arc of fire. It is this excellent distribution of their 8-inch guns which makes the *Saratoga* and *Lexington* actually the most heavily armed carriers in existence. Two Japanese ships, the 26,900-ton *Kaga* and *Akagi,* mount ten 8-inch guns, but these are mounted singly along the ships' sides and well below the flight deck with the result that only five of them can bear on either beam. Consequently, these Jap carriers have a broadside fire of only five 8-inch guns.

The twelve 5-inch, 25-caliber anti-aircraft guns, firing shells weighing about 50 pounds, are mounted singly along the ships' sides. They are grouped in four positions just below the flight deck, which is somewhat recessed to give them as wide an arc of fire as possible.

The *Saratoga* and *Lexington* each has a maximum capacity of about 106 aircraft; under normal conditions, however, only some 80 are carried. Normal complement consists of a complete Air Group of four 18-plane squadrons plus a number of reserve and utility planes. The *Saratoga,* as flagship of Carrier Division One, Battle Force, Pacific Fleet, has, in addition, a two-plane flag unit. One of her squadrons consists of scouting planes, another of bombers, a third of fighters, and the fourth of torpedo planes.

These aircraft are housed in the spacious hangar located just below the flight deck. Here also the planes can be fueled, repaired, and loaded with bombs or torpedoes. Two large elevators convey them from the hangar to the flight deck. This latter, 880 feet long and 85 to 90 feet wide, is 60 feet above the water-line. At the bow, a catapult, 155 feet long, launches the heaviest planes into the air at a flying speed of better than 60 miles an hour. On the starboard side are two powerful derricks for lifting seaplanes a flying boats out of the water.

The defensive characteristics these great ships have never been o cially disclosed, but they are believ to include a wide 6-inch armor b running some 600 feet along the wat line, a 3-inch deck over such vi spaces as the magazines and engi and boiler-rooms, triple hull constru tion, and anti-torpedo blisters bulges. This protection, particula the deck armor, may recently ha been improved.

THE *Saratoga* and *Lexington* we designed for a speed of 33.25 kno which they both have exceeded in a tual service. Their machinery—Ge eral Electric turbines with elect drive—is the most powerful ever i stalled in a warship. Sixteen boil with a pressure of 295 pounds p square inch provide steam for t turbo-generators which supply curre for the eight 22,500 horsepower el tric motors. Two of these motors a connected to each of the four propell shafts. On one occasion the *Lexin ton* made the 2228-mile voyage fr San Diego to Honolulu at an avera speed of 30.7 knots and on anoth maintained a speed of 34.5 knots f one hour. Fuel oil capacity is 70 tons, an enormous amount, but n

U. S. Navy Official Photo

Eleven more of these important naval vessels are under construction or on order for the United States Navy, as of June 1, 1942

excessive in view of the daily consumption of some 2000 tons when the ships steam at full speed.

Although sister-ships, the *Saratoga* and *Lexington* are not identical in appearance. They can most readily be differentiated by the platform around the top of the latter's funnel. This platform is lacking in the *Saratoga*. Both ships can easily be distinguished from any of our other carriers by their huge flat-sided funnel. This funnel, which is really a single casing enclosing a number of boiler uptakes, rises 79 feet above the flight deck. Whatever its merits, it certainly offers an excellent target to the enemy.

Our first carrier originally designed as such is the 14,500-ton *Ranger*, authorized in 1929 and laid down two years later by the Newport News Shipbuilding Company. She was launched February 2, 1933, and commissioned for service 16 months later at a cost of about $19,000,000. Her water-line length is 728 feet, her beam just over 80 feet, and her mean draft 19 2/3 feet. Her complement, including flying personnel, amounts to some 160 commissioned officers and 1650 enlisted men.

The *Ranger* mounts eight 5-inch, 25-caliber anti-aircraft guns, sixteen 1.1-inch machine guns, and 24 smaller ones. Her armor protection is very scanty, comprising only a one-inch deck and a thin patch of side plating over the engine- and boiler-room spaces. For defense against torpedos, mines, and near bomb misses, she relies on her double hull and internal sub-division below the water-line.

Recently the *Ranger* has been carrying 84 aircraft, which is just about her maximum capacity. Two of her four squadrons are composed of scouting planes and the others of fighters. A dozen reserve and utility planes complete her brood.

Aside from being our smallest and most lightly protected carrier, the *Ranger* is also the slowest. Her 53,500 horsepower geared turbine engines, driving two propellers, give her a designed speed of 29.25 knots. On trials she just exceeded 30 knots with 58,700 horsepower.

The *Ranger* differs radically in appearance from our other carriers. On the starboard side on her flight deck she has a small island superstructure and a short tripod mast, but her funnels or smoke ducts, of which there are no fewer than six, are located near the stern, three on each side of the flight deck. They are very thin and short and can be lowered outboard in a horizontal position while aircraft landing-on operations are in progress. For the past several years she has been assigned to Carrier Division Three, Atlantic Fleet.

The 19,900-ton *Yorktown* and *Enterprise*, authorized in June 1933, were laid down in May and July of the following year at Newport News. The contract price for their hulls and machinery amounted to $38,000,000, but the actual cost worked out at a considerably higher figure. Including armament and aircraft, these ships cost around $25,000,000 each. They were launched in 1936 and commissioned for service two years later. Their completion and final acceptance by the Navy was delayed by serious mechanical defects which developed in their engines and boilers. In the *Yorktown* this trouble necessitated the replacement of the reduction gearing and of more than 1200 boiler tubes.

The *Yorktown* and *Enterprise* are 761 feet long on the water-line, 809 1/2 feet over-all, and have a beam of 83 1/4 feet and a mean draft of 21 2/3 feet. Their flight deck, which commences some 15 feet short of the bow and extends about the same distance beyond the stern, is approximately 800 feet in length.

These ships carry eight 5-inch, 38-caliber "dual purpose" guns, sixteen 1.1-inch anti-aircraft machine guns, and numerous smaller weapons. The

(Please turn to page 82)

Motion Study Goes Human

Workers Co-Operate in Achieving Increased Production

Efficiency Through Time and Motion Research

ALBERT RAMOND
President, The Bedaux Co., Inc.

At a table in a factory office a lone watcher sits behind a portable movie projector, facing a portable screen. As he watches the screened action, he writes occasionally on a sheet of paper—writes a kind of engineering shorthand. And this watcher differs further from the ordinary movie fan in that never does he say, "Well, this is where I came in," and get up and walk out. Rather, he sits through the same sequence over and over; and as his film, in the form of a loop that does not require rethreading, spins through his projector again and again, he goes on writing.

Now he snaps off the projector motor switch and, operating the machine by hand, examines his picture frame by frame. And still he writes. . . . Thus, with the aid of motion photography, which suffers no slips of memory, overlooks no details, and measures time in thousandths of a minute, modern-day scientific management goes about the task of streamlining production methods in many of America's war industries, conferring benefits alike on worker, employer, and on the all-out war effort. By means of movies, filmed in electrically-driven cameras whose speed is synchronized precisely with the speed of the projectors, production engineers are enabled to study workers' motions in order to improve and simplify methods of work.

Motion study is but one of the tools in the modern production engineer's kit. Scientific management, an extension of a field first explored by the late Frederick W. Taylor, concerns itself also with such matters as time study and establishment of production quotas, plant layout, planning, scheduling and routing of the production flow, training of workers and supervisors, and incentive plans to reward workers equitably for extra effort.

And in every step of the procedure of improving production and management methods, modern-day scientific management enlists the workers' interested co-operation, thus insuring between management and labor the wholehearted kind of teamwork that America's wartime production job demands. The techniques employed produce substantial results.

To cite a recent instance, production engineers, in a plant that produces gun mounts and earth-moving equipment, helped increase output in a bottleneck department by 102 percent. Meanwhile, thanks to the workers' increased productivity, wages went up while costs declined.

In this instance, it was the engineers' findings, derived from study of the movie records of workers' motions, that led directly to the department's improved achievements. Here, as in many other instances, motion study disclosed a need for jigs and fixtures for holding and rotating heavy work; and here, as has often been found in other cases, the installation of jigs and fixtures not only stepped up production but also reduced the workers' fatigue and contributed to their safety.

Let's look as this last-mentioned phase of the matter more closely. As the engineer - turned - photographer watches his movie film unroll, he keeps vigilant watch for signs of wasted energy—signs that experience in similar studies in many other plants has taught him to expect.

Let's assume that, in the course of his step-by-step survey of the operations in a plant department, he has set up his camera and photographed a worker's cycle of operations at a punch press. Now, as he sits behind his projector to run off and to study the photographed record in detail, the engineer watches for the answers to such questions as these:

Are the worker's motions symmetrical—that is, do the right and left hands reach, grasp, carry, hold simultaneously; or does one hand frequently wait for the other? Is the work so arranged that motions are short and smooth; or are they long and jerky? Can the working surfaces be so arranged that work need not be picked up, but may be slid into place? Can the weight of the work be reduced? Are there periods during which a hand or an arm must assume a cramped position—perhaps to hold work in place—and will a jig or fixture reduce fatigue and enhance accuracy?

Thus, step by step, the engineer diagnoses. Next he prescribes. Motions, work arrangement, jigs and fixtures—all details are noted that need correcting. On paper he creates an improved work-cycle. Then, back at the punch press, the new routine is explained to the pressman.

"Looks better," the pressman concedes.

"Try it," the foreman suggests.

The pressman tries it and says, "It *is* better."

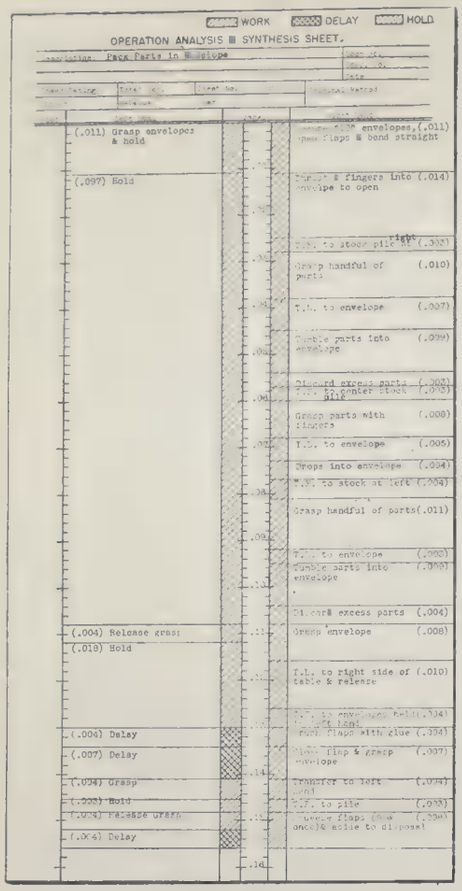
"In a few days, after you've got the hang of it," the foreman tells him, "We'll bring the camera back and shoot another picture. I think we'll be surprised at the difference."

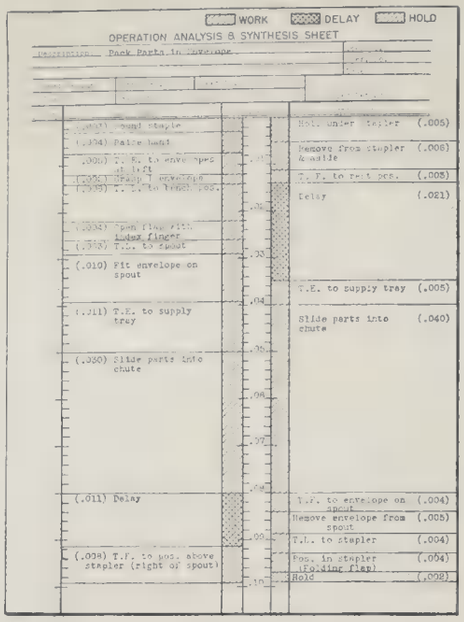
Seldom, however, is the engineer greatly surprised; experience has taught him that when the second loop of film comes back from the developers it will run but half or at most two thirds the length of the first. That much motion and time will have been saved. And the engineer, having run the second version through his projector for checking, may recommend still further changes in method, or he may file it away for future reference—and for use, perhaps, in training other workers.

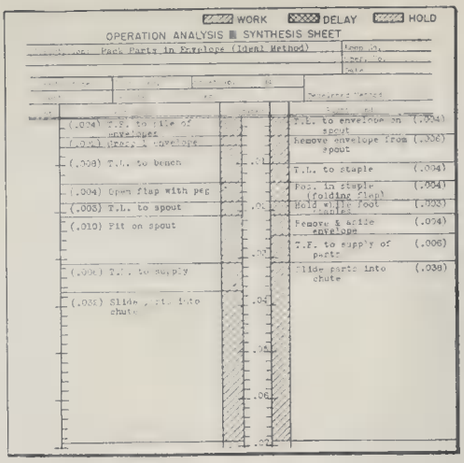
Thus, step by step through a department or through a factory, motion study discloses the little energy losses—losses that, added together, a few seconds here and a few seconds there, have been found to add up to hours and hours of time.

Time study was mentioned a few paragraphs back. The primary object of time study is to measure work accurately and, by scientifically determining normal rates of production, to obtain a yardstick for comparing what is being accomplished with what could be accomplished under reasonably efficient conditions. Such a study, often coördinated with motion study—in fact, the two are frequently carried on simultaneously—makes possible setting of equitable rates of pay, with extra reward provided for extra effort.

Here must enter the workers' enlightened understanding. In one large plant the time-study man is the president of the employes' union. Collaborating thus, guided by accurate time studies, and allowing liberally for fatigue and other factors that influence production, both management and labor may feel sure that the wage rates that result will be fair.







Results of a camera analysis of a simple bench operation consisting of placing a number of small spare parts in a paper envelope. The operation as originally observed took up the time of 156 frames of motion-picture film, in which one frame is one exposure corresponding to 1/1000 of a minute. The operation cycle was, therefore, .156 of a minute. The most noticeable thing disclosed by this study is that the right hand (chart at extreme left) is working for the entire cycle, while the left hand is working for only .012 of a minute and is used for holding for .129 of a minute or about 83 percent of the cycle. By re-locating parts on the bench and re-allocating the work on both right and left hands, the total cycle was brought down to .099 of a minute (chart in center), a reduction of 36½ percent. Then the stapler used to close the envelope was modified to be foot-operated. This permitted a further reduction of the cycle to .069 of a minute, or 30 percent more, giving a total reduction in time, over the original of nearly 56 percent (chart at right). With the foot-operated stapler, both hands are used in a productive manner all of the time except that the right hand holds the parts under the stapler for a period of .003 of a minute

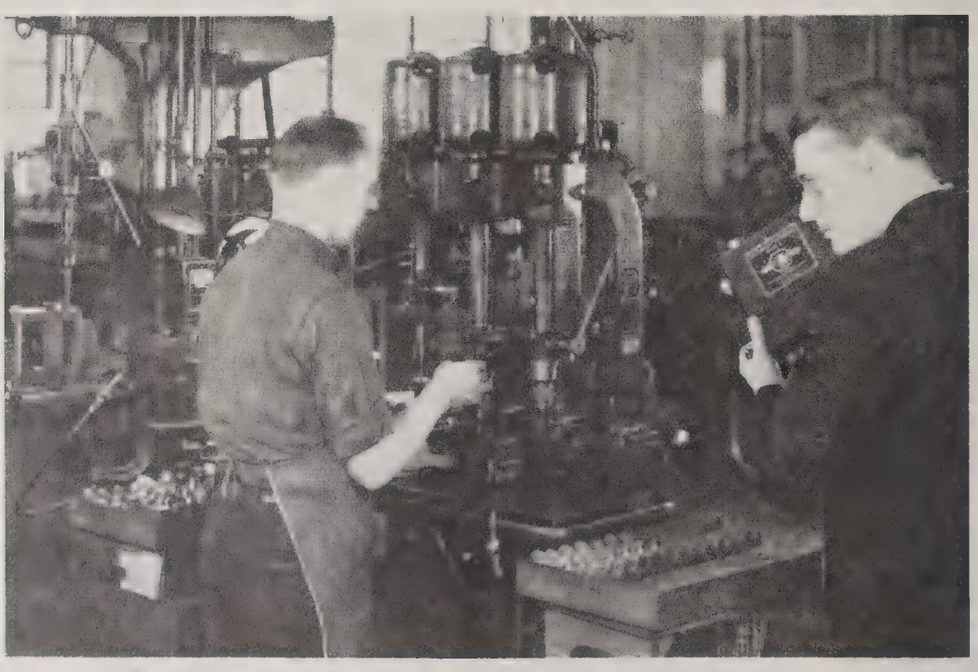
Time study does even more than this. Because it records elapsed time in terms of productive and non-productive effort, it highlights time-losses and the reasons for them. These reasons may include defects in plant layout, or slips in planning and scheduling the production flow from machine to machine, or from department to department. Or the losses may be due to delays in receiving materials, tools, or instructions.

In an ordnance foundry, better planning and a complete overhauling of the method of compensation—permitting workers to earn more when producing more—resulted in increasing output by 110 percent. In this plant the erstwhile slowest worker now is the fastest. Methods had been improved. Potentialities for earnings—his own and his colleagues'—had been increased. Should he, who used to be the laggard, now become a one-man bottleneck and slow down a whole department? Not he! Promptly, he stepped out in front; and, as a producer, at this writing he still leads.

In a steel-casting plant that, among other things, makes anchors for warships, production engineers found that nearly everyone, at one time or another, stood around, waiting. The engineers found moulders waiting for sand and for patterns. They found pattern makers waiting for orders. They found truckers, trundling their trucks through the aisles between the moulders, waiting for the moulders to get out of their way.

Again the engineers prescribed rearranging, rerouting, and rescheduling. Orders, it was provided, would go to the pattern shop fore-handedly enough so that patterns would reach the mouders on time. Sand would go to the moulders, not through the aisles—which were the moulders' working space—but along the rear, and thus clear the working space for work. At one spot, a stoppage-point in plant traffic, a flight of stairs was replaced by a ramp to make easier the trip from one level to another. Rearranged, this plant stepped up its production 96 percent—and workers' earnings went up substantially.

To be sure, not always are production delays so obvious; but, in times such as these, when production, because of pressure of the war demand, often must be gotten out by main



Taking a movie from which time and motion studies will be made

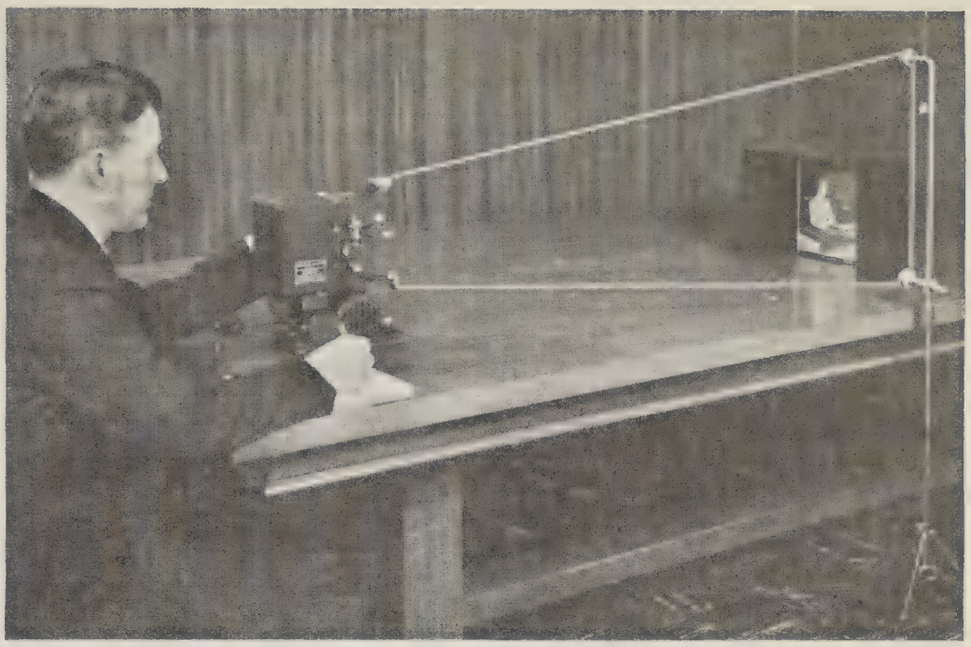
strength, even glaring delays are frequently tolerated because they seem to be necessary evils. But trained observation just as frequently shows that these evils are not necessary at all.

Detailed study of operations almost invariably reveals certain bottlenecks —sometimes divisions or whole departments—the true effects of which have not even been suspected. Thus, in a plant that makes seamless tubing for aircraft, job studies disclosed that stoppages in the annealing department could be eliminated by assigning certain technical tasks to the personnel of the plant laboratory instead of to production men as had been former practice. When the stoppages had been cleared, the plant's over-all production went up 42 percent.

Not only in enterprises where operations are repetitive and more or less standardized, but also in maintenance and repair work and in those fields of industry where each successive operation may differ from those that have gone before, modern methods of production control have stepped up output. For example, a warehousing operation that handles steel sheets, bars, angles, and other steel shapes—all essential materials in our industrial war program—ran far behind its service potential, until production engineering technique rearranged such warehousing functions as classifying, segregating, stacking, inventorying, and even cataloging. These improvements, together with a replanning of the crane service, enabled the warehouse to improve its over all performance by 44 percent.

SIMILARLY, it was an overhauling of layout and a rerouting of the flow of work that enabled production engineers to bring about a seeming miracle in the maintenance department of a great steel mill. In this mill, rearrangement of planning methods brought about production increases in four major repair shops, ranging from 72 to 128 percent. Incidentally, with equipment scarce and with machinists becoming still scarcer, proper control of maintenance work in almost any kind of factory becomes increasingly vital.

Fortunately, both labor and management well realize today that in winning the war each side has a stake. On an ever-broadening front, labor has accepted as socially and economically sound the principles of scientific management and has participated in their application. In part this attitude is the result, of course, of the war program. In part, and even more important in the long run, it is the result of the adoption by management of a broader, enlightened labor policy.



A motion-study engineer views a loop of film over and over again

Through the years, one of labor's major objectives has been greater security. And because, through these same years, *efficiency* came to be linked in the workers' minds with loss of jobs, the word became unpopular. Meanwhile management, having come to realize that in its employe relations a good deal was lacking, had begun to overhaul its personnel policies and its methods of production control. It is to further this overhauling—this humanizing—of policy that present-day production engineering, far from laying aside the techniques of scientific management, now applies those techniques with labor's co-operation.

ARE the methods of a factory to be examined and improved? Openly, frankly, and fully, supervisors and the production engineer talk the matter over with the men. Are operations to be studied in detail? The workers help. They know what is afoot and —more importantly—they know why. Are wage rates to be established? The workers are taken into the procedure. The workers do more. In instance after instance, having watched production engineering step up output, they have gone on the alert for opportunities for still further improvement; they have come to management and said:

"Look here! Everything's fine as far as we've gone; but we haven't gone far enough. At least, *you* haven't. Here is something you have overlooked."

That something usually turns out to be a managerial blind spot—a lapse in planning or supervision. The bottleneck eliminated, the workers say:

"O.K.! Now we can go places with this plant!"

Time after time, experience has proved that a proper approach to a solution of the problems involved in increasing production brings a favorable reaction from everyone concerned. A broader application of these principles—a development for which management must assume the primary responsibility—would provide a vital stimulus for our war effort.

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IRON-GLASS SEAL

Made Possible by New Invention

TIGHT seals between iron and glass, eliminating the need for nickel and cobalt, critical war metals, for wires leading into certain types of vacuum tubes, are now being made with a new development of Dr. Albert W. Hull and Dr. Louis Navias, General Electric scientists.

From early days of the electric lamp, a problem of construction has been to make a tight seal between metal and glass. It is also involved in making radio tubes. Even with tubes in which the glass shell is replaced by one of metal, the lead-in wires pass through glass insulating bushings.

The difficulty is that most kinds of glass expand with heat at a different rate from that of the metal. Glass and metal may be tight at one temperature, but when they are heated, the glass will either crack or pull away from the metal, because the change in their dimensions is not the same.

Platinum was used in the first electric lamps, since it has nearly the same rate of expansion as the glass then employed. Various substitutes for platinum were devised which

were satisfactory for lamp seals, though they were not adapted to the large seals used for powerful vacuum tubes, for example. However, Dr. Hull and others developed special nickel-iron-cobalt alloys for this last application.

Since nickel and cobalt are used in many ways for war equipment, and their supply is extremely limited, the new invention of Dr. Hull and Dr. Navias is an important one since, for certain applications, it permits tight seals to glass without their use. They have devised a series of glass compositions which can be used with iron and certain iron alloys. One consists of 45 percent silicon dioxide, 14 percent potassium oxide, 6 percent sodium oxide, 30 percent lead oxide, and 5 percent calcium fluoride. The rate of expansion of these glasses is very close to that of iron.

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FORGERY—Many forged checks can now be detected instantly at a bank teller's window by means of an ultra-violet ray lamp developed in Westinghouse laboratories. All checks are coated with fluorescent chemicals which glow brightly in the dark when irradiated with invisible ultra-violet. Any erasure or change on the checks removes part of the chemical coating even though the alteration cannot be seen in ordinary light. Under ultra-violet the tampered part of the check shows as a dark blotch.

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STANDARD STEELS

Can Speed-Up Production For War Needs

PRODUCTION of steel for war equipment is being facilitated as steel producers and consumers concentrate more and more on making and using a relatively small group of standard steels rather than literally thousands of special-order steels.

The standard steels on which emphasis is being laid consist of a group of 87 alloy steels and 77 carbon steels selected after a two-year period of study and research by top-ranking steel plant operating executives and outstanding metallurgists working through the American Iron and Steel Institute. Hitherto, carbon and alloy steels had been made in more than 4000 different combinations of chemical elements.

Last year the groups of standard steels represented approximately 90 percent of the total output of carbon steel, 70 percent of the alloy steels made in open hearth furnaces, 85 percent of the electric furnace alloy steels, and 100 percent of the stainless steels.

In 1942, it is expected that standard steels will constitute an even greater proportion of the total steel output.

Steel plant efficiency has materially improved along with the greater production of standard steels, and both producers and consumers are sharing the advantages of large-scale production.

Efficiency has been improved in many ways. By enabling steel plant operators to assign a furnace to the more or less continuous production of one class of alloy steel, such as chrome-molybdenum, the crews which work on the furnace on the present round-the-clock schedule have a chance to improve their performance by specializing in producing that one class of steel. When a great variety of specifications had to be met, it was more difficult for the crews to develop a routine of high efficiency.

Standardization also has resulted in fewer "off-heats" which must be discarded or diverted because they do not comply with consumer specifications.—*Steel Facts.*

PLANE CONTROL

Made Smoother by New Rubber Bushings

THE development of a new material to be used for bushings and guides of the primary controls of an airplane has just been announced by the research department of The Firestone Tire & Rubber Company. This new material is a composite construction of a special rubber compound, a special cotton fabric, and a new method of impregnating the assembly after vulcanization.

Because of its elastic properties, bushings and guides of this new material provide, without restriction of action, a tighter fit than has previously been possible with conventional type guides and bushings. Combining shock absorption qualities and the ability to minimize lost motion, it contributes to smooth operation of the plane.

The new material is being used mainly in bushings and guides for the rudders, elevators, and ailerons of planes.

REFLECTOR

For Fluorescents Releases Steel for Other Uses

DEVELOPMENT by the fluorescent lighting fixture industry of a new type reflector, constructed of materials not vital to war production, was announced recently by the Lighting Division of Hygrade Sylvania Corporation. An industry-wide change-over to this type of reflector would release, for more critical war production, important quantities of steel currently used in reflector manufacture.

Because fluorescent lighting makes more efficient use of electrical power and provides more light of better quality, it is considered an extremely important factor in 24-hour-a-day war production. It is being used in a great majority of war production plants, and thousands of fixtures are being manufactured for this purpose daily. The fixtures utilizing the new composition reflector will employ only about 1/3 as much steel as present fixtures, and thus the amount of steel made available for other war production will be considerable.

Made of a specially treated composition, the reflector is considerably

Out come new reflectors

lighter in weight than present reflectors. General appearance, however, remains the same. The reflecting surface is the same high-temperature synthetic enamel used on many present Hygrade fixtures, and has equally high light reflectivity.

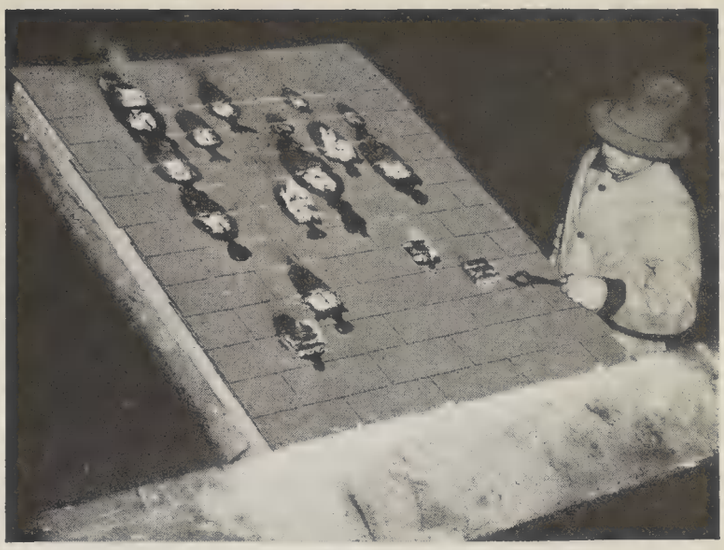
FIRE RESTISTANT

Roofing Proved in Grueling Tests

FEW home owners think of the roof as one of the most fire-vulnerable parts of a building, yet sparks landing on combustible roofs have been responsible for 55 of every 100 conflagrations in this country since 1900, according to figures compiled by the National Fire Protection Association.

On the other hand, there are instances where fire, sweeping across a section of a city, has stopped when it reached a community in which fire-resistant roofs were in the majority.

The choice of roofing, therefore, is not one for the individual alone, but for the community as a whole, to influence. More than 600 cities and towns in the United States permit only fire-resistant roofing within their fire limits, and this number is growing



Left: Wind-blown flames melt asphalt, do not set roof deck aflame. *Right:* Firebrand test

almost daily. Either in peace or in war, such protection is a first line of home defense.

Much of the credit for the present high standards of fire-resistant roofing belongs to the Fire Underwriters' Laboratories in Chicago, which, as one of its many fire-protective functions, tests and classifies roofing according to the fire protection it will provide under actual fire conditions.

Testing and classifying of fire-resistant roofing is done by duplicating roof construction and fire conditions at the laboratories. A section of roof, built of wood like that of an average house, and covered, for example, with asphalt shingles, is placed on an inclined framework before a wind tunnel. In the mouth of the wind tunnel there is a three foot wide gas flame. This flame, with the gas pressure carefully regulated, is then blown against the surface of the roofing by a 12-mile-an-hour wind from the tunnel. The flame is applied intermittently, two minutes on and two minutes off. To pass this test successfully, there must be no flaming on the underside of the roof deck at the end of the test period.

To determine the protection which asphalt roofing—the most widely used fire-resistant roofing—will provide against the danger of flaming brands being blown on to it, further tests are made with actual burning brands of various sizes. These are placed on a new test sample and allowed to burn themselves out. Here, again, the period should end with no flaming of the underside of the deck.

A third test measures the ability of the roofing to prevent the spread of flames. In this case, a 1400 degree, Fahrenheit, flame is blown continuously against the surface of the roofing; the distance which it progresses is noted. This indicates whether the roofing adds any fuel to feed the fire.

These tests, combined with several others, determine whether or not the roofing is readily flammable, and whether or not it carries or communicates fire. They also show the degree of heat insulation the roofing provides for the combustible structure underneath and whether—in a fire—the roofing will slip from place and create a flying brand hazard.

• • •

WIRE—A strand of wire reaching from New York to Montreal, a distance of 469 miles, can be produced from a rod of tungsten 5½ feet long having a diameter slightly larger than a lead pencil.

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TEST SAVING

By Generating Electricity With Airplane Engines

NEW airplane engines which once consumed great quantities of aviation gasoline but did no useful work during break-in runs now have been harnessed to produce enough electric power to supply all machines and lights in the factories where the engines are built, according to R. H. Wright, an engineer at the Westinghouse Electric & Manufacturing Company.

"In this way, one new airplane engine on test actually drives machine tools producing parts for other engines and at the same time saves electricity needed for other war factories," said Mr. Wright.

The new power-producing method has been achieved by harnessing the airplane engines to ordinary electric generators of the type long used in small Diesel-electric power plants. Westinghouse already has supplied one large airplane engine manufacturer with 16 of the generators. Mr. Wright continued:

"Every airplane engine runs about half a day in a specially constructed test cell before it is built into one of our fighting skycraft. It is first given what aeronautical engineers call a 'green' run to unlimber it. Then the engine is taken apart, inspected, and reassembled for a final break-in run.

"In some engine factories, 40 or more of these cells are in use continuously. As a result, engine manufacturers are among the largest users of aviation gasoline. For example, in one plant, engines on test have burned more than 1,500,000 gallons of this fuel in one month."

By installing generators in test cells, each aircraft engine can produce about 2000 kilowatt-hours of electrical energy during its test runs. Mr. Wright explained. Generators now in use in one factory will produce each month more than 4,000,000 kilowatt-hours, worth about $24,000. That much electricity is enough to supply the entire factory — driving lathes, drills, grinders, boring machines and other machinery used to manufacture airplane engines—including lights. In less than two and one-half years, it is estimated the generators will pay for the additional cost of installation.

The generators can also operate as motors to crank the stiff, new engines for their first trial run. Then, after the engines gain speed under their own power, the electrical machines automatically become generators, producing power instead of using it. By measuring the amount of electricity generated, engineers can tell whether the engine is running properly. Such accurate checks are not possible when the engines drive propellers in test cells not equipped with generators.

Test cells that use generators can be built smaller and less expensively. Propellers make so much noise that their cells must be built larger and with sound baffles to keep them from being a civic noise nuisance.

INDUSTRIAL TRENDS

RUBBER COMPANIES, AS CONVERTED

THE fact that rubber is vital to the conduct of a modern war has been hammered home so thoroughly that it hardly seems necessary to give it even one more tap. We can, therefore, in this column dismiss for the moment this well-understood fact, and also disregard the subject of natural-*versus*-synthetic elastomers, to pass along to certain data of interest regarding the rubber companies themselves. From such data can be obtained a clear picture of the entire rubber industry as it stands today; from this picture can be deduced with some degree of certainty the general trend.

When the average person thinks of the products of a large rubber company, the first thought is, quite naturally, of vehicle tires. Yet, in peace-time, over 30,000 different products make use of rubber in one form or another and it is this versatility that makes rubber of such tremendous value in times of war. The manufacture of such a wide range of products calls for the application of research and engineering knowledge of no small moment, and for a diversification of such knowledge in many fields that, ordinarily, would not be considered in any way related to the rubber industry. This knowledge—the fashionable word of the moment is "know-how"—is essential for progress in the commercial world of peace; in war-time it becomes invaluable to the country holding it. Up to the start of the war it led the rubber companies into many new fields, and in some measure prepared them for what was to come.

As a result, a general survey of the five largest rubber companies shows that all of them are managing arsenals. Individual tire-makers are producing in large quantities such war material as airplane sub-assemblies and anti-aircraft gun carriages. One company is turning out machine tools, while the industry as a whole is in production on barrage balloons for protection against enemy aircraft. Such, briefly, is the over-all view. Let's look closer at the five largest rubber companies.

Goodyear: Normally the world's largest tire producer, this company is now rated as one of the largest suppliers of airplane sub-assemblies, supplying specified units to at least five aircraft plants. Also manufactured are airplane wheels and brakes, bullet-sealing fuel tanks for planes, rubber life-rafts, gas-masks, barrage balloons, semi-rigid airships for coast patrols, and so on.

Operating factories in seven foreign countries, and owning rubber plantations in the Netherland Indies, Philippine Islands, Panama, and Costa Rica, Goodyear has the heaviest foreign investment of any rubber company.

Firestone: Now reported to be the largest producer in the United States of metallic clips for machine-gun cartridges, this company is also manufacturing such non-rubber items as oxygen tanks, airplane wheels and brakes, and Bofors anti-aircraft gun mounts and carriages. Among rubber items being made are gas masks, life rafts, and tank track blocks. Tires, which ordinarily constitute 70 percent of Firestone's output, continue as one of its most important products.

Although Firestone operates factories in seven foreign countries, its most substantial investment outside the United States is in rubber plantations in Liberia, on the west coast of Africa. These areas have not yet felt the hand of war, and are considered to be highly valuable.

United States Rubber: Manufacturing nearly every product made of rubber and being the country's largest producer of non-tire rubber products, U. S. derives only slightly more than one half of its total sales in normal times from tires and tubes. Thus the non-tire rubber requirements occasioned by war are of material benefit to this company. Barrage balloons, bullet-sealing fuel tanks, and rubber life-rafts are some of the military products which U. S. is making.

Goodrich: Here is the one company of the five under discussion which has gone in heavily for development of the synthetic rubber field. At the same time, it has also broadened its operations in natural rubber. Credit is given to Goodrich for the endless rubber tread now being used on high-speed military scout cars, and for the de-icer for airplanes which operates by inflation and deflation of a rubber section on the leading edge of the wing. Also being made are balloon and airship cloth, bullet-sealing tanks, and military tires.

In the field of synthetic rubber, Goodrich is found to be part-owner, with Phillips Petroleum Company, of Hycar Chemical Corporation, the nation's largest producer of the petroleum-based synthetic, butadiene. Goodyear also makes the rubber-like synthetic known as Koroseal and, in 1940, put into commercial production automobile tires using the synthetic rubber called Ameripol.

General Tire and Rubber: Mainstay of this company's business always has been vehicular tires. But, some five years or so ago, there was opened a General plant for the manufacture of non-tire items. As a result, this mechanical goods division was ready to do its part in the war effort when required. Thus, the output of all types of tires is being supplemented by General's manufacture of barrage balloons, wind socks, gas masks, and molded airplane parts.

That's the way the rubber industry shapes up in the present war effort. Add to the above the fact that each and every one of these companies is managing one or more government-owned arsenals for the production of TNT, small arms ammunition, powder-bag loading, and so on, and it is evident that the rubber industry is doing at least its share in the present war. It is also obvious that it will come out of the war effort with a vastly increased amount of "know-how" that the rubber companies will be able to apply to their operations in the field of peace-time production.

STEEL IS PERFORMING

BEHIND the iron and steel that are playing such an important part in our war effort is an industry that has alternately been cursed and blessed throughout its existence, an industry that despite its size is sufficiently diversified and flexible as to have survived world-wide criticism and to have been ready for emergencies when they arose.

Critics would have us believe that the bigness of the steel industry, its financial strength and integrated management, its ability to control valuable processes, are all undesirable features that should be overcome. But let those same critics see how the steel industry is meeting the present requirements of economical operation, is making extensive savings in the use of precious alloying metals, is operating at virtually 100 percent capacity and, if they correctly interpret the trends, they will realize that the very features which they criticised most loudly are those features which are making it possible for the steel industry to contribute largely toward winning the war.

—The Editors

OUR *Point* OF VIEW

"GET TOUGH"

"In war you cannot afford the luxury of squeamishness. Either you kill or capture, or you will be captured or killed." Not pretty but, unfortunately, factual to a ghastly degree for both armed forces and civilians in today's world. The quotation is from Captain W. E. Fairbairn, formerly of the Shanghai Military Police, lately instructor of the British Commandos, and now on loan to our own armed forces. The Captain's new book, "Get Tough," embodies his years of experience in the art of rough and ready self defense and offense with the hands as one's only weapons. It is not nice reading. It tells casually and coolly how to gouge, break an opponent's arm, leg, or neck—but, unpleasant as the subject matter may prove to many readers, its underlying philosophy is the only acceptable one for Americans who desire to continue "our way of life."

It's about time we did get tough. In six months of war we have lost thousands of men, hundreds of ships, untold tonnages of food and war munitions—which, nevertheless, our taxes must pay for—to say nothing of the Philippines, Wake and Guam Islands, and portions of the Aleutians. We lost face with other nations, both friend and foe, and, worst of all, we lost some of our own self respect. What did we win? We won the battles of the Coral Sea and Midway Island and many smaller engagements, tactically important, but hardly compensatory with our losses.

These comments have nothing to do with our armed forces. At Pearl Harbor, Wake, Bataan, Corregidor, on the seas, and in the air our fighting men have indelibly recorded *their* toughness in their own blood on the pages of history's newest tome. But what of the rest of us?

We were a tough people during the dark days of '76 and the long years that followed. We were tough in 1823, when a man in the White House spoke important words to all the world, words later called the Monroe Doctrine. We got "that way" after the Alamo; when the battleship *Maine* was sunk; when a Kaiser and his henchmen torpedoed shiploads of our women and children—but are we that way now?

That fellow, Schickelgruber, and his pesky little yellow cousins in crime think we aren't. For their own sound reasons they do not question the hardihood of the boys in blue and khaki—but what of the rest of us? Are we tough enough? Do we realize that this Thing that is loose on our gory globe is so big, so strong, so ruthless that unless we in the United States all get tough—and soon—we may suffer the loss of many idealistic and realistic things, things that will make the present commodity shortages seem extremely picayune?—*A.D.R., IV.*

WHAT'S AN AMATEUR?

The amateur works because he cannot help it, impelled by a love of the work he does.

Today the amateur home mechanic is helping to win the war in at least three specific ways: as a "bits and pieces" machinist bending over a cellar lathe at home after regular working hours while the owls hoot outside; as a repairman reconditioning firearms for home-guard uses; and as a precision optician making parts of the optics of armament to fight Hitler.

All three of these amateur movements have been organized and are now in actual production. The results they have given are changing the meaning of the word amateur. What is an amateur?

The trouble with this two-headed word is that it means two different things that sometimes actually march in diametrically opposite directions. It means, first, a dilettante who makes a superficial pretense. But it also means a man who practices an art for the love of it. Now, when it turns out, as it is turning out more and more often, that the man who practices an art for the love of it equals, or even excels, the professional who works mainly to earn a livelihood and sees little romance in what he does, the word amateur comes to connote something not derogatory but entirely good.

The program for home machinists has been described in other publications. Hundreds of lathes and other machine tools in cellar and attic shops have been put to work on bits and pieces of armament, their owners becoming sub-contractors.

The National Rifle Association has organized those of its members who are gunsmiths in a program for reconditioning old rifles of standard caliber. It also is endeavoring to round up for similar uses as many as possible of the old Springfield rifles which had been sold to private individuals and to put them to better uses than lying in attics.

Scientific American, since last autumn, has quietly organized in a program some of its thousands of amateur telescope makers. A limited number of these advanced workers have already demonstrated that the amateur who works mainly for the love of the work, or for the hate of Hitler's regime, can successfully do precision optical work of a grade of difficulty that is looked upon even by most professionals as ultra, and which some of them find it prudent not to tackle. Several of these amateurs now hold primary contracts, and some of them, if they continue to make good on the promise contained in their preliminary successes, will no doubt be able to expand their home shops into much larger plants.

There is today far less tendency to look down the nose at the amateur than there was a generation ago, for the amateur has proved up in too many ways. The classic example of this proof was the help given in World War I by the American Radio Relay League, about which everyone has often heard. The War Department discovered that it had among those amateur "hams" a huge reservoir of virtual virtuosi in radio engineering. Since then it has been far easier for amateurs of any kind to get a straight-faced hearing, and today the professional who low-rates the amateur is likely to be warned by some other professional that he had "better look out, or that fellow you scorn will soon be catching up and blowing on the back of your neck."

There is no longer even any need for the amateur to over-compensate by being cocky and assertive. In most places he meets with an honestly co-operative reception and an intrigued interest in what he is trying to do. Sometimes the professional envies him, for the amateur hasn't had his fun spoiled by having to make a living from it.—*A.G.I.*

Housing on the Double Quick

Factory Production-Line Methods Applied to Speed Construction and to Conserve Building Materials

GEORGE MICHELSON
Vice President, J. Slotnik Company, Boston, Mass.

On a 600-unit housing development to accommodate personnel at a Navy Yard, practically the only tool the carpenters used in the field was a hammer. The explanation of this unusual operation was complete pre-cutting of all lumber, each piece being plainly marked when cut and stacked near the fabrication yard. When the foundations were ready, the lumber for the floor of one building was hauled to point of use, followed, as required, by all the framing lumber and then by plumbing, roofing, and electrical materials. Trim and interior finish came to the work cut to size and was completely assembled in a job fabricating shop. Erection utilized production-line methods, a crew doing only one operation on a house, then passing on to the next building.

Pre-cutting and assembly-line techniques were adopted by the contractors to conserve material and to meet an expected shortage of skilled help in an area where little construction had been done in the last ten years. This solution of the labor problem was based on the expectation that an unskilled man would become efficient quickly by working at the same job day after day.

Before ground was broken the contractor analyzed carefully the operations necessary for construction, and agreed on 22 essential operations for the construction of the one-family units with only one more operation necessary for the double units. The next step was to estimate the number of man-hours required to perform each operation and select proper size crews to keep each portion of the work "in step." Sufficient crews were then organized to insure the desired overall progress on the project.

Field supervisory forces consisted of a general superintendent to whom an assistant general superintendent, the expediter, and the office manager reported. The assistant general superintendent held direct supervision over field engineers, inventory control of warehouse and mill, assistant superintendents in charge of subcontract work, and operation superintendents directly responsible for several team captains in charge of small groups on the various essentials of construction.

The 600 dwelling units of the development are made up of 150 single units, 24 feet, 4 inches, by 28 feet, and 225 two-family units, 24 feet, 4 inches, by 55 feet, 8 inches. Each family section has a living room, kitchen, two bedrooms, and bath. No basement is provided but full outside walls are carried below the frost line. A storage space 10 by 10 feet is floored in the attic with access through a 30 by 30 inch scuttle. Heat is oilfired hot air, the heating unit (located in a kitchen alcove) supplying year-'round hot water. Electricity is used for cooking and refrigeration.

Exterior walls are two- by four-inch studs at 16 inch centers with one inch wood sheathing, building paper, and creosoted wood shingles. Roofs follow the same pattern as the walls but use composition shingles.

Interior walls are 3/8-inch thick fiber board nailed to the studs, no other wall insulation being used; the ceiling is the same material but has insulating batts laid between the ceiling joists; walls and ceilings are painted. Double houses have special soundproofing in the party wall, the insulating strips being zigzagged between studs facing each way to entirely break the connection between the units.

The supervisory men responsible to the assistant general superintendent were in charge of certain operations only, rather than over a particular area or group of blocks in which houses were being built. The contractor's plan of operations was to follow as nearly as possible the straight-line factory production methods except that the workmen move past the product in lieu of the product moving past the workmen. By organizing the work in this way, a minimum of non-working foremen were required. Within each group of men working on a particular operation was a team captain with two-fold duties. First, he was responsible for maintaining the rate of progress established for his "team"; secondly, it was his responsibility to his team to make certain that their materials were at hand. The exercise of these duties kept the teams alert and active. Each man, after an operation was started, quickly realized his importance to his team; a "ringer" posing as a carpenter was quickly routed out by his teammates to better their production rate.

A system of inventory control was set up to conserve material and prevent waste. The inventory control served not only this function but also alleviated the unskilled labor situation by supplying all possible parts ready to use, thus substituting routine operation for general craft skill. In order to carry this out successfully, it was

Rough framing of single and double units, and rough boarding of a single unit. In foreground are pre-assembled window frames and studs cut to length

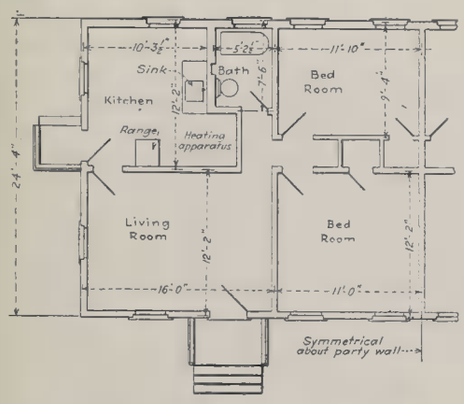
Courtesy "Engineering News-Record."

necessary that the proper amount of the materials required for each operation be made continuously available to the craftsmen. If workmen were obliged to look for a piece of lumber or were allowed to exercise choice in the use of lumber, this method of operation would have failed.

A carpenter shop 150 feet by 80 feet was set up for the purpose of milling the framing lumber and building up such sections of each house as it appeared could be economically prefabricated. The mill was made of adequate size so that when the milling operations were nearly completed, the mill could be transformed into a suitable shop for pre-cutting the wallboard and also for setting up door frames and hanging doors and installing hardware.

At the time that the engineering staff divided the job into the various operations, full-size details of every piece of lumber going into the house were prepared. This was carried out even to the preparation of blocking for plumbing fixtures. The next step was to determine which members could be economically built up and delivered to the house location ready for installation.

All the lumber was cut in advance



Floor plan of half of a two-unit house. Single-unit plan is similar, but with a bedroom window in what here is a party wall dividing the two dwellings

and, where possible, partially assembled in the shop. Sills were cut for positions above and below windows and the short studs nailed to them in the proper length to fit in their marked position.

Incoming materials were received by a stock control supervisor who assigned them either to the warehouse or to the mill. Lumber assigned to the mill was placed upon gravity conveyors which fed two lines of radial-mounted circular saws. Each saw was set to make one cut, after which the piece passed on to the next saw. For a hip rafter the first cut was a double mitre on the front end of the piece, after which it was measured to a

Trees were carefully protected during house construction, and every care was exercised in locating the homes to take advantage of the contours of the site

templet and marked for two straight bevel cuts on the opposite end and then passed to the next saws until all cuts were made. Each piece was marked to show its exact location in the finished work.

Excavation for water and sewer lines and for the outside walls of each house was carried to a depth of four feet. Truck-mixed concrete was used for an 18-inch wide, 12-inch deep footing under the exterior wall with 18-inch square footings for the interior columns. Bricklayers then placed concrete block walls and columns to the height required to accommodate the building to the existing ground.

The material for a complete floor system was collected on a truck at the storage yard and hauled to the building site and piled—not dumped—as close to the work as possible. (Skids and tractors were used during the spring thaw.) The exact number of pieces of lumber required were taken to the work and if one was broken it was returned to the yard for replacement or, if taken for other purposes, a special explanatory requisition was issued. Unsatisfactory lumber was culled during the operations carried out in the carpenter shop. Savings in waste, in rehandling of material, and in reduced confusion are believed to have compensated for the few trips necessary to the storage yard for replacement material.

Floor framing was started by laying stringers over the center piers, followed by floor joists set in place at 16-inch centers and lapped over the center stringer. Bridging, already cut for quick handling, was nailed in place, followed by the sub-flooring, not precut, which was placed over the entire area; the edges were trimmed with a portable electric saw. Necessary openings through the floor were cut later by a special crew.

As soon as the floor was laid the framing for the rest of the structure was brought to the site and piled so that material required first for construction was on top. The walls were assembled on the completed floor, the previously sawed-to-length studs, and sills with short studs, expediting the operation.

FOLLOWING the same procedure there was delivered to each house the exact quantity of side wall and roof paper, asphalt roof shingles, creosoted wood shingles for side walls, including pre-cut wood shingles for gable rake, window frames, sash, and wallboard. Doors were fitted, hung, and hardware installed at the mill so that they were delivered as a complete package to each house and the field work involved merely the erection of the unit in the rough opening left in the framing. Some of these details are shown in the illustration on the opposite page.

Shipments of material from the warehouse or the lumber yard were made in accordance with definite schedules. Variations from the scheduled quantities were reported immediately, investigated, and rectified. Use of this method of controlling materials proved that building mechanics can be trained to follow schedules; that waste can be eliminated; that the cost of maintaining the inventory control system is much less expensive than the cost of waste; and that, at no extra expense, rubbish can be greatly reduced.

Star of 1054

Our Crab Nebula Proves to be a Guest-Star Strikingly Observed in China 900 Years Ago

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

In the western part of Taurus, due north of Orion, a fairly bright nebula was observed and catalogued by Messier. Later, some imaginative observer called it the "Crab Nebula." Its sponsor must have had as lively a capacity for seeing figures in the sky as blessed the ancients who named the constellations, for it is a somewhat irregular oval mass, which looks more like a potato than a crab—but the name has stuck to it, and is now generally used, at least in English.

By whatever name it is called, it is one of the most remarkable objects in the sky. It is of moderate size, about 6′ by 4′ in extent, and shows the familiar nebular bright lines—forbidden lines of oxygen and neon and ordinary lines of hydrogen and helium—all superposed on a faint continuous background. So far, there is nothing unusual, but Lampland, at the Lowell Observatory in 1921, comparing photographs taken at an interval of eight years, found that the nebula was in motion, and measures by Duncan at Mt. Wilson confirmed this.

Later photographs by Duncan extend the interval of observation to nearly 30 years, and reveal the character of the motion clearly. It is illustrated in our illustration (from Duncan's paper of 1939). The arrows show the observed displacements of each of the measured points, multiplied by 17, so as to get the motion in 500 years.

It is evident that the nebula is expanding in all directions, and at a very rapid rate, astronomically speaking. Carrying the observed lines of motion back, they all pass close to the point indicated by the white dot which has been inserted in the figure. (There is no such thing in the nebula.) The small discrepancies in direction probably arise mainly from uncertainties of measurement of the nebulous condensations, which are not very sharply defined. Carrying the motion back in time as well as in space, it appears that all parts of the nebula started from this central point at nearly the same time, about 800 years ago—the discordances being again attributable to uncertainty in the measures.

This suggests almost irresistibly that the nebula owes its origin to some great outburst, about eight centuries ago, near the marked point, which ejected masses of gas in all directions, and with somewhat different velocities, whose persistent outward motion has resulted in the observed picture.

If some of these gas-masses were thrown out almost directly toward the Earth, or away from it, they would appear to move slowly, even if they were really moving as fast as the rest. This explains why the central part of the nebula is also bright.

A conclusive test of this interpretation may be made spectroscopically. If the light of the central region really comes partly from gas on the front side of the expanding mass, moving toward us, and the rest from gas at the rear, moving away, the lines in the spectrum of the first should be shifted toward the violet, and those of the second toward the red, giving double lines—somewhat like those in the spectrum of RW Tauri, described last month, but arising this time from motions straight out from the center, and not in a circle around it.

Double lines were observed in the spectrum of this nebula by Slipher at Flagstaff in 1913. Spectra adapted to accurate measurement, taken by Mayall at the Lick Observatory in 1936, showed that the velocity of the outward motion for points apparently near the center of the nebula was 1300 kilometers per second in each direction—falling off toward the edge of the nebula—as we might expect, since the motion of points in this region should be nearly crosswise to our line of sight. This makes it certain that the nebula is really expanding. Assuming that the rate of motion is the same in all directions, its distance may be calculated. Duncan finds 1250 parsecs, or 4100 light-years. The greatest diameter of the nebula, as we now see it, comes out about six light-years.

This is not the first known case of an expanding nebula. The gaseous envelope surrounding Nova Aquilae of 1918 (which is still faintly visible, and still expanding, at a uniform rate) was undoubtedly formed by ejection of matter from the star, literally under our eyes. Hence, as soon as the expansion of the Crab Nebula was discovered, the suggestion was obvious that it owed its existence to some similar outburst eight centuries or so ago. Since the Crab Nebula is still fairly bright, the catastrophe which produced it was probably of extraordinary magnitude and visible as a very bright Nova.

Lundmark, in 1921, pointed out that certain Chinese records described the appearance of a "guest-star" in the right part of Taurus, and in the year 1054 A.D.—translating the Chinese constellation and year into our familiar system. This is almost 900 years ago, instead of 800, but it would hardly strain the observations of the fuzzy moving nebular condensations to fit them to this slower rate of motion, and the hypothesis that the Crab Nebula was produced by the outburst of a new star seen in China in 1054 has ever since been regarded as probable. New evidence, just published, appears to settle the question in the affirmative.

Professor Duyvendak of the University of Leiden—a distinguished authority on matters Chinese—has discovered, in other ancient chronicles, several additional references to the "guest-star" which appeared in this year. For example, "In the first year of the period *Chih-ho*, the 5th moon, the day *chi-ch' ou* (July 4, 1054) a guest-star appeared several inches south-east of *T'ien-kuan* (ξ Tauri). After more than a year it gradually became invisible," and from another chronicle: "It was visible by day, like Venus; pointed rays shot out from it on all sides; the color was reddish-white. Altogether it was visible for 23 days." References to this object are also found in chronicles written in Peking, and in Japan. These detailed records were evidently due to the belief that the appearance of this strange star was a portent of things to come; but they preserve information of much scientific importance which has been discussed by Professor Oort, of Leiden,

and Dr. Mayall, of Lick Observatory.

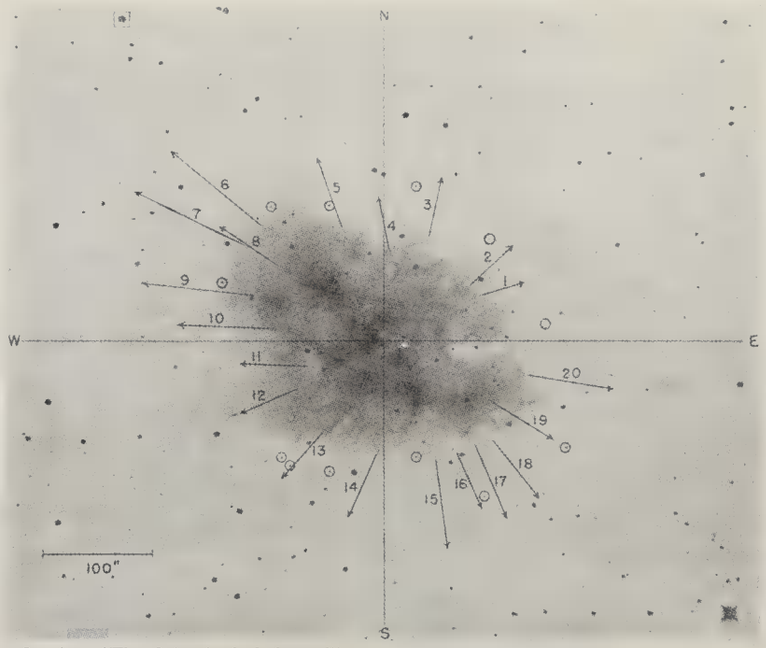
The great brightness at maximum, combined with the known distance of the Crab Nebula, show that the "guest-star" of 1054 was a supernova of unusual brilliancy.

To be visible by day, like Venus, it must have had an apparent visual magnitude of about −4; but this is rough, for the Chinese had no way of estimating how much brighter than Venus it was. Even at this long interval, we may improve this rough value. The 23 days mentioned in the ancient chronicle evidently refer to the interval during which the star remained visible in the daytime. Now, three super-novae in distant extra-galactic nebulae have been well observed in recent years. Their light-curves were remarkably similar—the decline in brightness in 23 days after maximum being 1.3, 1.5, and 1.6 magnitudes. Hence it is reasonable to assume that at maximum the star of 1054 was 1.5 magnitudes brighter than when it was last seen in the morning after sunrise, by observers who had followed it through the dawn. The limit of visibility under these conditions is about −3.5 magnitude, so that the supernova at maximum must have been near −5.

The region of the Crab Nebula is affected by the absorption of light by the thin dust-haze which is widely present in the Galaxy, and causes distant stars to appear fainter and redder than they would otherwise look. From measures by Stebbins and his colleagues, of stars in the same region and at about the same distance, it appears that this absorption amounts to about one magnitude.

HAD it not been present, the star of 1054 would have been at maximum of visual magnitude −6, and brighter than any other celestial object on record except a few comets. With the distance of 1250 parsecs, this corresponds to an absolute magnitude of −16½, or to nearly 300,000,000 times the light of the Sun. This might put a strain on our belief, were it not that the brightest recently observed super-nova, which appeared in 1937 in the nebula I.C. 4182, had the well-determined absolute magnitude −16.6 —just a shade brighter.

Further evidence of the great brightness of the "guest-star" is found in the fact that, according to the Chinese records, it remained visible to the naked eye for some 650 days after its appearance. The super-nova in I.C. 4182 declined in brightness by 11½ magnitudes photographically in this interval. The visual change was somewhat less. Assuming the same for the earlier one, and that it was of the 6th magnitude when lost to sight, its maximum comes out at −5. This, by itself, is a rough value; but it shows that all the data are consistent with the belief that the ancient and modern super-novae were extremely similar. It is very remarkable that so much information is still available about an astronomical event which was visible nearly 900 years ago.



Courtesy "The Astrophysical Journal"

Arrows show the expansion of the Crab Nebula

No direct evidence is available about the later history of either super-nova, for that of 1054 sank beyond the reach of the naked eye and that of 1937 beyond that of the 100-inch telescope, when the real brightness was, in each case, about 10,000 times that of the Sun. We can be sure, however, that the star which produced the Crab Nebula has not gone out. The emission spectra of gaseous nebulae can be accounted for only on the assumption that some very hot star, within or close to the nebula, floods the gas with ultra-violet light of very short wavelength, which, in rather complicated but well-understood ways, sets the atoms of gas to shining.

Almost at the center of the Crab Nebula is a very faint double star, with components of the 16th magnitude. One of these appears to be a normal star; the other is very probably the surviving remnant of the super-nova. In visual light, it is now about half as bright as the Sun. Its ultra-violet radiation must be enough to maintain the visible light of the nebula, and probably much other radiation invisible to us. It may then be concluded that it is still exceedingly hot—probably more than 100,000° even at its surface. Without "telling tales out of school" the writer may reveal that an interesting discussion of this subject is soon to be published by a Western astronomer.

Meanwhile, we may note that this nebula presents a very striking instance of the complications which arise in trying to apply our ordinary time-conceptions to objects at vast distances.

The "guest-star" appeared—to observers on earth—early in July, A.D. 1054; but the stupendous explosion which gave it birth actually happened about 3000 B.C. We see it now as it was in 2100 B.C. with an uncertainty of a few centuries affecting both figures in the same direction and to the same extent. It appears to us now as a gaseous cloud of six light-years in extreme diameter; but that was its size in 2100 B.C. At present it must be almost 5½ times as big—if, indeed it is shining any longer.

WE cannot yet say whether the initial star can keep up its extraordinary ultra-violet radiation indefinitely or whether it is still drawing on and slowly exhausting a store provided by the great cataclysm. Even if it has remained without change for the 4000 years and more that separate the star as we see it from the star as it is, the nebula must be much farther from the star, much more feebly illuminated and much fainter. If the star has cooled to an ordinary stellar temperature, the light which the nebula reflects must be much too faint to be observable.

What it is like now—or, more precisely, what it will look like to the observers of A.D. 6000—is for the present a secret, perhaps to be revealed soon by theory, but otherwise in the very safe keeping of light-waves which at the moment are neither here nor there, but are buried inaccessibly in that vast portion of space-time which Eddington, in one of his moments of inspiration, has called the Absolute Elsewhere.—*Princeton University Observatory, June 3, 1942.*

Our Search for the Supernatural

Dunninger Explains How Table-Turning, Once Explored by Faraday, May be Accomplished

"TABLE-TURNING. *Spiritualism.* Movements of tables, et cetera, attributed to the agency of spirits."—Webster's International Dictionary, Unabridged.

More comprehensively, and according to Lewis Spence, author of "An Encyclopedia of Occultism," table turning is a form of psychic phenomena in which a table is made to rotate, tilt, or raise completely off the ground by the mere contact of the operator's finger-tips, and without the conscious exercise of muscular force. The modus operandi is exceedingly simple. The sitters take their places around a table, on which they lightly rest their finger-tips, thereby forming a "chain," as it is known in psychic circles. In a few moments the table begins to rotate, and may even move about the room, seemingly carrying the experimenters with it.

This apparent phenomenon has been for years, and still is, in high favor among spiritistic mediums as an alleged means of communicating with the spiritual world. The alphabet is slowly repeated, or a pencil is run down the printed alphabet, and when the letter the spirits desire to indicate is reached, the table tilts. Thus have been "dictated" sermons, poems, "information" regarding the spirit world, answers to sitters' questions, and, who knows—perhaps at Berchtesgaden, even the Nazi war strategy.

Table turning originated in America, spread to Europe, reached England early in 1853, where it became immensely popular.

So prevalent did table turning become that men of science were urged to turn the light of scientific knowledge on the "phenomenon" and to endeavor to explain it on rational grounds. Foremost among distinguished investigators was the English scientist, Michael Faraday. By means of a simple apparatus of his own devising Faraday showed that the movements of the table were due to unconscious muscular action on the part of the sitters, who were thus, themselves, the automatic authors of the messages purporting to come from the spirit world. The conclusion drawn from Faraday's experiments was that when the sitters believed themselves to be either pressing downwards, or not pressing at all, they were actually pressing obliquely in the direction they expected the table to rotate—an expectation generated, possibly, by an advance statement, frequently on the part of the medium or leader, that the table would first move in such-and-such a direction.

Then, as now, not all agreed with the conclusions pointed to by scientific experiments. Two of the earliest investigators became satisfied the table was motivated by a force radiating from the operators, a force they termed "extenic force." Others were less rational in their explanatory attempts and the public, on the whole, was disinclined to accept Faraday's scientifically reached conclusion. People seemed to prefer the spiritistic explanations, or the pseudo-scientific theories which asserted that the "chain" of operators formed a sort of electric battery which supplied the table with vital energy, or, as it was then called, "electro-odyllic" force. Other explanations offered were odic force, galvanism, animal magnetism, and—strangest notion of all—the rotation of the earth.

Raduano tilts 10-ounce table

The apparent phenomenon of moving, tilting, or levitating a table remains as much as ever an argumentative question between those who subscribe to the tenets of spiritistic control and those who do not. On July 21, 1941, Signor Raduano appeared before the Scientific American Committee for the Investigation of Psychic Phenomena, and tilted—not levitated—a small table of his own, as well as one belonging to the Commodore Hotel.

The signor was given complete freedom to utilize powers which he prefers to term "psychic" rather than "supernatural" to tilt his tables, but his failure thus far to re-appear for simple tests before our Committee—in accordance with his own agreement—left no choice but to refer the matter to Chairman Dunninger for an explanation.

In presenting our Chairman's views, it must be remembered that neither Dunninger nor the Committee maintains the following method was employed by Signor Raduano but until and unless the signor keeps his agreement to carry on his demonstrations under simple test conditions before the Committee, it will be accepted that this or some other mechanical device or means was utilized in Signor Raduano's table-turning exploit of July 21, 1941.

The three-legged table used by the signor was his own property. This was in accordance with our policy that "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." The signor's table was constructed of papier mache, or some other extremely light-weight substance, it weighed only 10 ounces, and was covered with a material resembling billiard-table-cloth in texture. Thus, the slightest friction between hands and table-top would tend to tilt the table. Whether or not the motion was accentuated by use of the right knee or the right foot cannot be factually stated, but one of the photographs taken at the time indicates that both these portions of the signor's body were in close proximity—if not in actual contact—with parts of the table. The hotel table, at the right in our photograph, weighed little more than the signor's special affair, and could likewise have been motivated by friction between its top and the palms of the hands. When a newspaper man was asked to place his hands on the outer, forward corners of the signor's table, and when the signor had succeeded in raising one table leg from the floor, the demonstrator removed his own hands, leaving the table poised on two legs, supported, apparently, by the palms of the newsman's hands. The slightest pressure, even unconsciously applied by the reporter, would serve to maintain the poised position of the 10-ounce table.

This report, supplementing the one in our March 1942 issue, closes the Raduano case, unless the signor desires to re-appear before our Committee.

Ships Off the Line

Science and Ingenuity Help Produce Cargo Vessels for the Emergency—and for our Future Merchant Marine

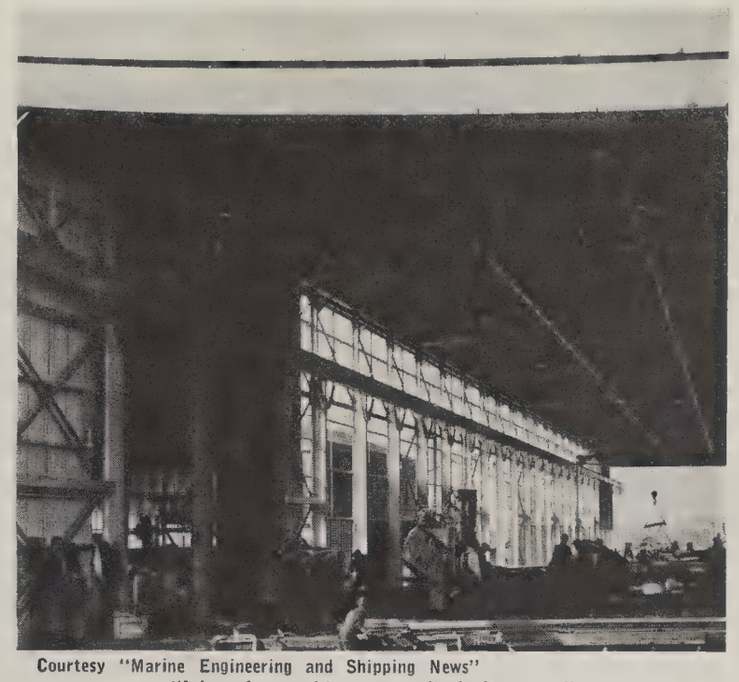
A. D. RATHBONE, IV

IT'S a long, thin room. It's filled—even in the daytime—with light-perforated dimness, the unending, clattering roar of giant rollers squeezing huge steel plates, the machine-gun staccato of riveters, and the hissing overtone of acetylene cutting and welding apparatus. This is an "assembly line" for production of Liberty ships, those 441-foot emergency cargo vessels that are now sliding off American shipways at the unprecedented rate of two a day—soon to become a near-miracle of three a day.

This third-of-a-mile-long room, 300 feet wide, is the fabrication plant at one of Bethlehem Steel Company's several shipbuilding yards; it's never quiet; and into the great maw, which is the receiving end of the building, are fed daily, from stock piles, enough steel plates to enable workers to cut, shape, and weld the 400 hull-plates necessary in the construction of one Liberty ship. There are 16 ways in this yard. Throughout the United States there are now 60 great shipyards aggregating more than 300 ways. Together they will produce and put into service 2300 ocean-going merchant ships by the end of 1943. Approximately 1500 will be the 7200 gross-ton Liberty vessels; slightly more than 300 will be tankers; most of the rest of the ships will be the modern C-types, destined to form the nucleus of America's great post-war merchant marine. Some idea of our present merchant shipbuilding program may be had by comparison with similar efforts in World War I. The present plan is nearly twice as big in its five-year scope from 1939 to 1943 as was that of the other war in a seven-year period—2486 ships aggregating more than 25 million deadweight tons, against 1911 ships during the last war totaling over 13 million deadweight tons.

Why is it necessary for us to set up such a stupendous plan—a plan that will demand every ounce of energy for its accomplishment? There are several very sound answers.

The battle fronts of today are in every far-flung corner of the world, and requirements of our war-production and delivery set-up must, therefore, depend on maritime commerce on a much vaster scale than ever before. Secondly, last time we had the use of cargo carriers from France, Italy, Japan, and other nations. It's different this time. Add to these the deplorable condition of the shipbuilding industry and our merchant marine before hostilities broke out. Shipbuilding had fallen to its lowest level of production when the United States Maritime Commission was brought into existence by the Merchant Marine Act of 1936. Then we had but 10 shipyards, with only 46 ways capable of producing 400-foot ocean-going vessels—and half of those were occupied with naval construction. Significant, too, is the fact that between 1922 and 1937 American shipyards produced but two ocean-going cargo vessels, other than tankers and liners.



Courtesy "Marine Engineering and Shipping News"

"It's a long, thin room, dimly lit . . ."

● THIS IS A WAR OF SHIPS . . . . Rear Admiral Emory S. Land, Chairman, United States Maritime Commission, stated in the April issue of "Marine Engineering and Shipping News" that: "This is a war of ships! American shipbuilders and shipworkers hold the destiny and freedom of the nation in their hands.

"Every hour lost in building a ship—no matter how it is lost—every work stoppage or slowdown—no matter why—is repudiation of that responsibility. . . .

"Ships built in time are truly Liberty ships.

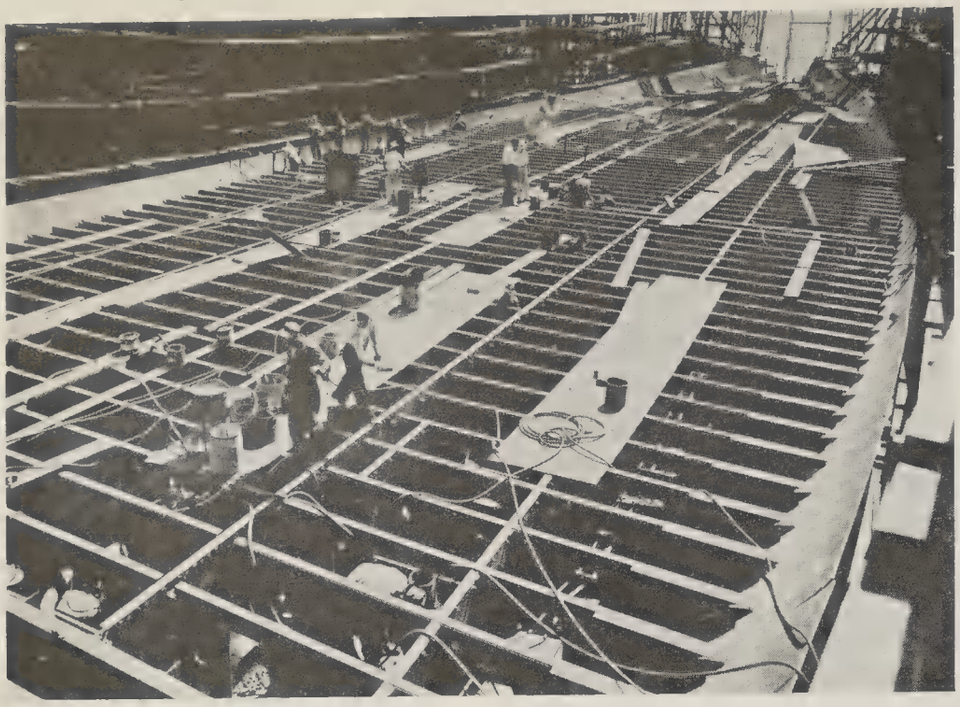
"Too late, they will be slave galleys for Americans.

"The men who build ships and the men who command them cannot fail America. Knowing them as I do, I am confident they will not fail." ■

A primary purpose for the establishment of the Maritime Commission in 1937 was to devise plans for construction of new merchant ships to replace worn, obsolete, American merchant marine ships, virtually all of which had been constructed prior to 1922. Late in 1937 the Maritime Commission proposed to construct 50 ships a year over a 10-year period. From that modest beginning there has been a constant mushrooming of the program to the point where American shipbuilders now *must* produce an average of a little more than three ocean-going ships a day to meet the war needs.

The original annual quota of 50 ships was doubled when Hitler set fire to the world; it was doubled again in 1940, and, in January, 1941, the yearly goal was set at 400. However, not only were the existing shipyards—then 18, with 70 ways—incapable of producing more ships than already were scheduled, but the limited capacity for production of turbines and gears, the most modern propulsion machinery for the C-types of vessels originally developed by the Maritime Commission, had been fully absorbed by the then-existing program. That condition brought the Liberty ship—Emergency Cargo Vessel—into existence. The maritime Commission was forced to adopt specifications for a ship propelled by reciprocating steam engines, a vessel not comparable to the already-approved Maritime Commission designs which called for the finest, most efficient, and swiftest merchant ships ever built—but, Liberties could be built faster, ever faster!

Never before had the shipbuilding industry of any nation been called up-



"Build more ships faster to win the war," says Rear Admiral Emory S. Land

on to utilize the ingenuity and efficiency necessary to produce 10,000-ton cargo ships in so short a time. Handicapped by lack of ways and yards, lack of steel, and a serious shortage of skilled workers and experienced supervisory ability, America's Maritime Commission and cargo vessel makers literally and figuratively rolled up their sleeves and went to work. They took a most important leaf from the automobile manufacturers' book—assembly-line and mass-production methods—and altered it to fit their needs. "Standardization" was the watchword. The Maritime Commission became the purchasing agent for everything that goes into the Liberty ships—from steel plates and engines to galley equipment and table linen, from windlasses and fuel-oil heaters to radios and gate valves. This ever-growing stream of thousands of items is retained in the Commission's central pool and consigned to the 60 yards as required.

A spread-the-work program has placed orders for ships' parts with 500 large and small plants in 32 states. Everything is uniform, so that no matter who makes it, it will fit in any Liberty ship. Worker training schools, under Maritime Commission authorization, are bringing out thousands of new skilled workers each month. Today, more than a million are employed in our American shipyards. Pre-fabrication of many parts, as well as pre-assembly of units, was successfully accomplished. Specifications were simplified to save time and essential materials. Welding took the place of riveting—Liberties are 85-percent welded. More ways and more yards were built, almost overnight, and all were laid out, so far as possible, to permit straight-line production. Schedules were expedited from the originally contemplated six months for one ship to 105 days, with greater speed-ups still to come. All this took place during a feverish 1941.

Then came Pearl Harbor.

One month later President Roosevelt called for an expansion of this already huge program by another 50 percent, and a later directive brought the goal to 2300 ocean-going merchant ships by the end of 1943.

LET'S go back to that long, thin, dimly-lit room and see what manner of miracle is making this biggest shipbuilding program of all time click so well.

The first step is to unload the steel at the railroad siding. The storage yard beside this Bethlehem plant—only one of many, remember—receives 6000 tons a week, and on one day recently 127 cars of steel arrived. Enormous steel plates are carried by crane and flat-car into the pre-fabricating plant, where they are cut and formed. Much of the cutting is done by an instrument called a Travograph, in which four oxyacetylene cutting tips simultaneously slice four identical shapes from 5/16-inch steel plates with extreme and continuous accuracy. In this shop two of these multiple cutters, working full time, cut enough storage tank pieces—and they are legion—to supply all ships produced by this yard. In Travograph cutting, as in all such steel cutting, or "burning," for ships' parts, templates or molds, previously constructed in the mold-loft to full size of the ships' sections, are used to insure accuracy. Measuring lines, identification marks, rivet holes, welding spots are copied from template to each plate or piece so that later workers will know what they have and where it goes.

Farther along this 1380-foot assembly line the welders get in their work. As an indication of the extent to which arc-welding is used as the method of fabricating steel work one of the nations' larger shipyards has installed enough welding equipment in an open-air assembly line to keep over 3000 men busy operating more than 1000 welding arcs 24 hours a day—and that's only one shipyard! Frames, deck sections, bulkheads, bow assemblies, and other parts are formed and fabricated. Someone estimated that approximately 35 miles of arc-welded joints are made by manual operation and more than 7½ miles by automatic operation in each Liberty ship. On railroad flat-cars these sections are delivered to the ways, where keels have been laid and hulls are beginning to take shape.

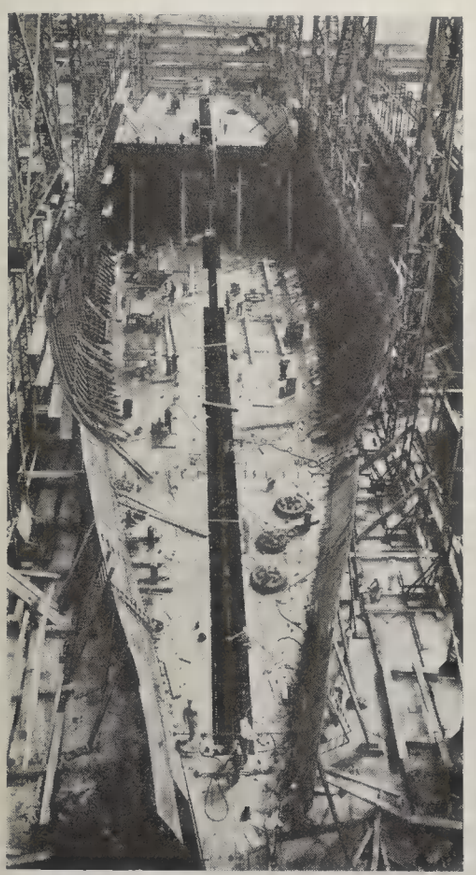
With a precision that amazes the layman, the myriad parts unerringly find their way to their pre-destined locations. This is the job of the erectors and shipfitters, who can read and

The welder is vastly important in the construction of our Liberty ship fleet

understand the weird hieroglyphics painted on the parts and assemblies. A small army of reamers, drillers, riveters, chippers, "burners," and welders swarm over the hull in what may seem the height of confusion, but in reality the co-ordination of plans, material, and labor in American shipyards is maintained on an exacting scale, as proved by the reduction in construction time from the prescribed 105 days to three months in many instances, and recently a Liberty ship came off its ways 46 days after

the keel of the ship had been laid.

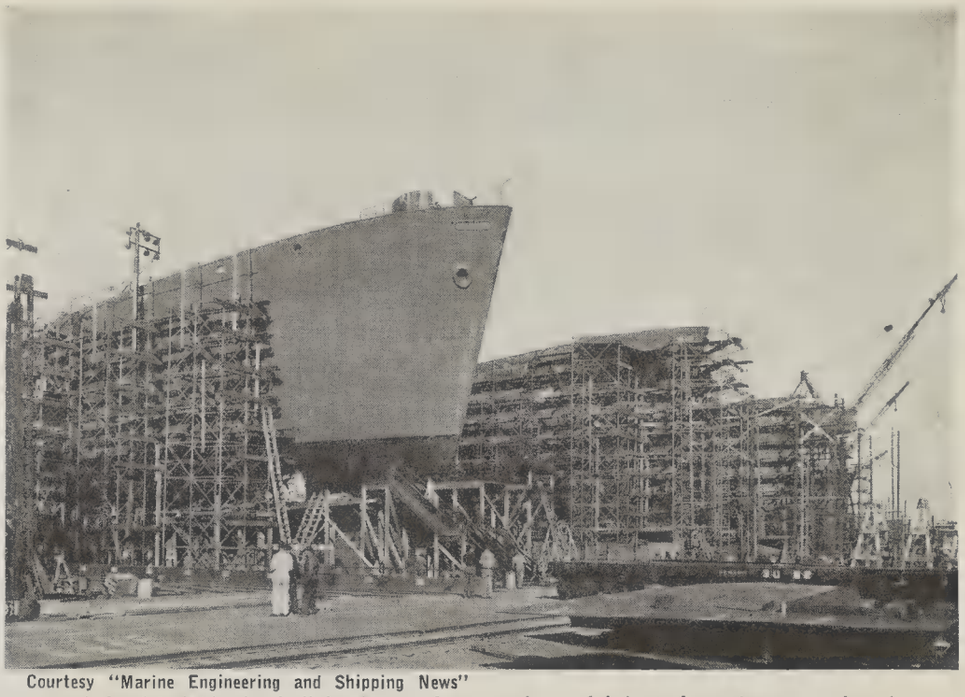
When decks and hatchways have been installed, the ship is launched—still an imposing spectacle, even though more commonplace these days. The ship moored to outfitting piers, welders, electricians, steam-fitters, and other artisans complete their particular installations. Altogether, some 500,000 man-hours are needed to produce one Liberty ship, and with increasing rapidity they are leaving their outfitting piers for their rigid



From high above on the scaffolding, a Liberty ship has skeletonized form

test runs; but this speed-up of building in no sense implies sacrifice of ability or sea-worthiness. Rather, it is another reflection of Yankee ingenuity and abilities. While Diesels are not available at present to power these Liberty ships, it will be possible to replace present propulsion machinery after the emergency is over with Diesels, or with turbines and gears, thus making them into faster and even more efficient carriers.

All along the line the Maritime Commission's central pool of supplies has functioned in providing material and parts with which to build a ship, get it into the water, get it completely outfitted, get it ready for occupancy and for cargo service. Now, with test run over, the ship okayed for immediate use, the Commission makes its last move before actual service. Every single item is checked into its place. The larder is stocked, the pots and pans are in the galley, fuel tanks



Courtesy "Marine Engineering and Shipping News"

A keel is laid, the hull begins to form, and pre-fabricated sections are placed

are full of oil, the furniture in officers' and crews' quarters is in place and in perfect order, water tanks are filled—nothing is lacking now but a crew, a cargo, and a destination.

Across the bay from the shipyards are great wharves and warehouses, filled to capacity with the manifold munitions of war. There, too, await the highly trained and doughty seamen of the American Merchant Marine. After the Maritime Commission's final inspection and acceptance of the ship at the fitting-out pier, the newest Liberty steams across the bay to those docks, in charge of a temporary crew. Her captain and his men take her over, her holds are packed with every ton of war freight they can stand, and she is off to brave the Axis-born dangers of war-time shipping. Through cargo transportation she will do her share to make the Seven Seas once again the safe world highways of commerce they must be for a new and greater American Merchant Marine.

It is significant that even during the stress of war, American ship operators are retained to a great degree in their normal industrial function. Although the War Shipping Administration has taken control of merchant ships, the title to most of them remains with the owners, who continue to supervise their operation as direct agents of the Government. This policy of the Maritime Commission and the War Shipping Administration is indicative of the fact that war has not caused the abandonment of the primary objective of the Maritime Commission. If our merchant vessels survive the ravages of enemy action, war will have served as a medium for expediting our original Merchant Marine restoration program. And, with ship operators retaining identities in the present maritime structure, they may, without serious dislocation, resume their previous status when peace comes.

It seems clearly apparent that this nation will be called upon for years to come to provide the bulk of the ships and the sailors which will be necessary

Courtesy "Marine Engineering and Shipping News"

Larders are stocked—"soup to nuts"

to restore economic balance and stability to this war-shattered world. Never again should we allow our shipyards to be disassembled. Never again should we permit our merchant fleet to reach the low level of efficiency and competitive ability which it attained in the post-war years following 1918. With present capacity at our command, we *can* maintain the 1943 rate of production of 15 million deadweight tons—and even increase it—if future developments show needs for additional tonnage.

East-Coast Cattle Ranching

A Vital Industry Gains New Life Through Scientific Development of Pasturage and of High-Quality Stock

HAMILTON M. WRIGHT

WITH wartime needs putting the demand for beef at an all-time high, the 1942 slaughter of livestock in the United States is expected to include 28,000,000 head of cattle and calves, according to Secretary of Agriculture Claude S. Wickard. Thus, the progress of the beef-cattle industry in Florida and the neighboring tidewater states of Georgia, the Carolinas, and Virginia, creating a new cattle country in the South Atlantic Seaboard, is beginning to assume an important place in the nation's economy. Florida's 1942 cattle population is already estimated at 1,500,000 head by Florida state authorities, but they say that Florida alone, with an estimated 25,000,000 acres of range land available for pasture improvement with newly introduced grasses, will eventually support a tremendous increase in this number.

This prediction is understandable in view of a statement by an experienced cattleman, who has raised beef cattle upon a large scale both in Wyoming and Florida, that he can raise a steer at an over-all cost of three dollars a year on the Florida range, as compared with 15 dollars a year in Wyoming where cold weather makes prolonged winter feeding necessary.

However, as recently as 1923 the most chronic optimist would not have dared to predict prosperity for Florida cattle. From a low ebb at that period, brought about by the ravages of the fever tick, beef cattle in Florida have undergone a phenomenal change. With the practical eradication of this dangerous pest since then, thousands of pure-bred beef bulls, including Herefords, Black Angus, the huge Guzerat Brahma, and other superior beef types have been crossed and recrossed on the native scrub cows, descendants of Spanish stock first brought to Florida in the 16th Century, to produce a preponderance of first-rate beef cattle.

In Georgia and North and South Carolina, where ten years ago a prime beef steer was the exception, thousands of acres of land withdrawn from the cultivation of cotton and tobacco by Government order are rapidly being converted to improved pastures or to winter cover crops, including small grains and legumes, to provide feed for large numbers of sleek cattle.

Centered in Florida, the industry has swept swiftly up the Atlantic coast. Moss-hung plantations between Savannah, Georgia, and Charleston, South Carolina, where rice, indigo, and cotton once supported lordly establishments, have been transformed into cattle ranches. Visitors last fall to the famous old Combahee Plantation at Whitehall, South Carolina, about 60 miles below Charleston, witnessed the auction of 500 baby beef steers, the largest sale of its kind in that part of the country to date. Almost two score of fat stock shows, where prime beef animals are exhibited for prizes and sold to highest bidders, have been held in Georgia and the Carolinas this past Spring. Many of these animals are used to breed improved stock and some have supplied beef to army camps.

Herefords at home on a Florida range

What has caused the tremendous development of the cattle industry in the Southeast? The answer is, necessarily, not brief. The relatively mild climate for all, or a larger part, of the year, the availability of land for pasturage, good transportation, proximity of markets, all have contributed to make beef cattle a profitable venture in the Southeast. Yet one must look beyond these propitious factors, important though they are. Cattlemen from Arcadia, Florida, to Rocky Mount, North Carolina, will tell you that without the collaboration of science the cattle industry in the Southeast could never have advanced.

Truly, scientific achievement has effectively shown the way to conquer at least three outstanding obstacles which, beyond the memory of the oldest stockmen in the Southeast, had barred progress in cattle raising. These are, first, the cattle fever tick; second, lack of quality cattle; third, lack of improved pasturage and forage.

In the short space of two decades, men of science have contributed enormously to the solution of these problems. The scope of their cumulative effort can well be imagined, when it is considered that not only animal husbandry experts, including nutritionists, but plant pathologists, agronomists, mycologists, bio-chemists, bacteriologists, and, not the least, far-sighted cattlemen, often volunteers for co-operative research, have led the frontal attack. Contributing, also, is the enterprise of the County Agricultural Agents and other representatives of the United States Department of Agriculture, the extension services and experimental stations of the state agricultural colleges, and the livestock and agricultural experts of the railroads. These agencies have been and still are a potent force in educating the rank and file of stock-raisers as to how they can best benefit from the constantly expanding work of the scientists.

All-out efforts to eliminate the fever tick had begun in the Carolinas in 1917-1918 and in Florida several years later. The native cattle of Florida had developed some resistance to the ravages of the tick through constant infection, though it was not unusual for a cattleman to lose from 10 to 15 percent of his herd in late winter and early spring in areas where natural

All photographs courtesy Atlantic Coast Line Railroad

Powerful tractors drawing heavy water-weighted cylinders armed with eight-inch knives are used to knock down palmetto growth and to reduce it to matchwood. Ground so cleared is planted with grass that has proved its all-around value as cattle feed

pasture was at its worst at that time of year. Moreover, they were tough, stringy animals, of slight commercial value. Good beef animals, when imported, promptly died of fever. One of the biggest cattle ranches, containing 99,000 acres, near Arcadia, lost an entire herd of imported Hereford bulls, worth $7500, in a single summer from fever tick infection. Leading cattlemen, with the assistance of Government and state officials, organized a concentrated drive to eliminate this destructive cattle pest. Corrals, chutes, and "dips" were created throughout the cattle regions, and the stock was dipped in tick-destroying solutions.

Tick eradication also started fencing, which made the animals easier to get at and prevented infected animals from mixing with those that were tick-free. At the present time no less than 12,500,000 acres of range land in Florida are under fence.

With the practical elimination of the fever tick from the Florida ranges, pure-bred beef bulls began to pour into the state. They were crossed with the already acclimatized native cows and the progeny again and again mated to imported stock. The imported blood most widespread now in Florida livestock is that of the Brahma, sacred cow of India, which can stand heat because it sweats like a horse, and which can go far for water and feed. But the white-faced Hereford is also seen everywhere, and the state is now firmly established as a producer of fine beef cattle.

The third step in the creation of Florida as a scientifically operated cow country is the sowing or sodding of nutritious, introduced grasses in place of native grasses. Native grasses provide satisfactory seasonal grazing only; the native wire grass, for example, is liked by cattle only for two and a half to three months, after which it becomes tough, unpalatable. Improved grasses afford exceptional pasturage for eight or nine months or more of the year. Some of these improved pastures, in fact, will feed a steer all the year 'round. One of the biggest ranchers in south Florida winter-fattens his stock on para grass pastures. Cattle like the introduced grasses better than the native. They fatten on them quicker and do not wander so much.

Of Florida's 25,000,000 acres of cattle range, 3,000,000 acres so far have already been partially improved as pasture. This land requires only continued work upon it to be rated as fully improved, capable of supporting several times the number of cattle that now graze upon it. In addition, there is much land to which carpet grass *(Axonopus compressus)*, which is now almost a native of our southern states, has spread.

A dynamic change in Florida's progress as a cattle state came in 1936. At that time Florida cattlemen began large-scale planting of improved pasture with the financial aid of the Agricultural Adjustment Administration. Between the close of 1936 and January 1, 1942, 360,000 acres of improved pasture were put in with the aid of the AAA. Florida is now proceeding at an even faster pace; last year, cattlemen in that state put in 156,000 acres in improved pasture, with government aid.

An historic firm of Florida cattlemen, packers, and ship-owners are now operating two huge palmetto choppers on a day and night basis, clearing the ground of heavy palmetto growths for the sowing of pasture grass in the flatlands northwest of Lake Okeechobee in southern Florida. These machines comprise rotating steel drums, each weighted with 500 gallons of water and armed with eight-inch steel knives that reduce entire palmetto trees and the heaviest kind of shoulder-high palmetto brush to an appearance of chopped matchwood. They are drawn by Diesel Caterpillar tractors, each making a speed of four miles an hour. Each machine clears an acre an hour. The combined clearance of the two machines is, therefore, almost 50 acres a day. When the land has been cleared of palmettos, carpet grass is disked-in to start the pasture. The entire destruction of the palmettoes requires two additional applications of cutters, one year apart.

This sort of land clearance is going on all over the palmetto regions in the Florida cattle ranges. Within three months of disking-in the carpet grass, cattle are grazing on the new pasture. However, carpet grass requires three years to become firmly established, and it is helped by close cropping.

Far to the North, yet within the Coastal cattle belt, which extends more than one thousand miles North and South, near Wilmington, North Carolina, a famous agriculturist and stockman has developed a continuous grazing program for his dairy herd, by a scientific rotation of small grains, feed crops, legumes, and grasses. Eleven different crops are involved. This permits his cows to graze the year 'round in the open on rich, succulent green feed, and must be regarded as an im-

Above: The imported blood of the famous Brahma cattle strain is evident in this herd of Florida cattle. Brahmas (a pure-bred bull is shown below) are notable for their ability to withstand great heat

portant contribution to the livestock industry in the South. This plan, like others, which makes the animals do the work of harvesting in winter, is one of the factors that makes cattle raising in the Southeast so profitable. In this connection it should be pointed out, however, that the program represents a highly perfected grazing plan and that the majority of beef and dairy stockmen in the Southeast limit themselves to five or even as few as two crops on the list, although some cattlemen, farther South, carry their cattle successfully on improved pasture through the year.

A favorite grass in south Florida is the para grass *(Panicum purpurascens* or *Panicum barbinode)*, well known in south Florida and originally introduced from Brazil, used both as pasturage and also in silage in the winter feeding of cattle. This grass, a very fast grower, has been known to yield 30 tons to the acre under favorable conditions. The density of this crop can be inferred when it is considered that there are 43,560 square feet in an acre, and that to attain this result each square foot must average a production of more than one and one-third pounds of the grass. This grass has creeping stems sometimes as long as 30 feet and as large as a lead pencil. It takes roots at the joints and makes an upright growth of three to five feet. It has a tendency to choke itself by its thick root growth and must be disked before it is killed out by its own excessive vigor.

Among other grasses, especially developed for beef cattle in Florida, are Napier or elephant grass, which attains a height of six feet, and a new cold- and wilt-resistant selection of Bahia grass. The selection of Napier grass, evolved by the agronomy department of the University of Florida

College of Agriculture, represents but one of more than 4000 specimens of this variety of grass studied that would best meet cattle forage requirements in Florida. A new type of Bahia grass that is more cold-resistant and a better seeder than common Bahia, a native of Paraguay, has been developed by the United States Everglades Experiment Station. The painstaking selection process, often requiring at least five years of experimentation before the grass is released to stockmen, is just one of the methods employed in evolving improved grasses for the Southeastern cattle industry.

At Moore Haven, west of Lake Okeechobee in southern Florida, one cattle buyer during the past winter secured fine results with winter feeding of cattle for the market by using in silage 15 tons of black strap molasses to each 320 tons of para grass cut green. But now that molasses is getting scarce, it is proposed to use the residue from the citrus canning plants in a similar manner. Already, some 35,000 tons of dried citrus-pulp are being used as cattle feed per annum.

Florida and its sister tidewater states have undeniable natural advantages for cattle raising. Mild climate and plenty of rainfall permit continuous grazing for nine months in the year in certain parts of this territory and already for a full 12 months in other sections. Excluding transportation facilities and proximity to markets, in both of which the Tidewater States occupy an enviable advantage, the low cost of feeding cattle is the Circean lure that is proving irresistible to experienced cattle investors from other parts of the country.

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LAWNS

Grow Best When Planted In the Fall

There has been considerable controversy in the past as to the best seeding time for lawns, but it is now generally conceded that Fall is by far the best, according to a statement made by J. W. Lentz, Director, Scott's Advisory Lawn Service. In spite of this, Mr. Lentz estimates that about 70 percent of home lawn growers still defer seeding until spring; he stressed, in a recent interview, that spring grass seedlings are apt to perish with the advent of hot, dry summer weather.

Early September seeding is ideal, since the grass then has a good start before freezing weather. Even seeding done in winter months results in better lawns than when sowing is deferred until spring, for the seed will germinate during the early days of spring when the soil would usually be too soggy to work.

FINGERPRINT

Classifiers Wanted In War Jobs

Fingerprint classifiers will be appointed in Government service through an examination announced recently by the United States Civil Service Commission. The Bureau of Navigation in the Navy Department, the War Department, and other Federal agencies in Washington may make appointments. The salary is $1620 a year. There are no age limits. Since the last announcement for classifiers made by the Commission, the experience requirements have been reduced, and the field has been broadened to include

members of fingerprint clubs or other organizations who have had training in the Henry system of fingerprint classification.

Instruction in the Henry system, and, in addition, three months of appropriate experience in that system, may qualify applicants. Their experience may have been in Federal, State, or municipal bureaus, in the employ of private corporations or individuals, or in fingerprint clubs under professional supervision. Proof of experience must be submitted. Perfect vision is necessary. The written test will be a practical one on the identification of basic fingerprint patterns and classification under the Henry system.

Applications must be sent to the Civil Service Commission, Washington, D. C., and will be accepted until the needs of the service have been met. The forms for applying may be obtained at first- and second-class post offices throughout the country, or direct from the Commission.

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PAPER—Wood pulp (wholly or in part) is the source of nine-tenths of American paper.

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ASBESTOS SUIT

Designed for Rapid Use, Complete Protection

A NEW one-piece asbestos protective suit, which provides instant and complete personal protection against flame hazards in emergencies, consists of an upper-and-lower durable asbestos garment securely sewed together, with helmet, gloves, and boots attached to completely enclose and protect the wearer. The unit prevents the entry of flame, insulates against heat, guards the head from injury by falling or flying material, and enables speedy and effective work at the scene of emergency.

Flames can't enter

The helmet of the suit is made of laminated Bakelite, asbestos covered, and with front and rear aprons to protect the head and neck. A large window of heat-resistant glass in the hood permits unobstructed vision.

Quick access to the suit, made by the Mine Safety Appliances Company, is provided by a zipper opening extending down the front from neck to waist line. When closed, the zipper is protected by a flap held in place by two arctic buckles. Zipper fasteners at the wrist and lower sections of outside leg seams facilitate rapid donning of the suit. Wrists, ankles, gloves, and neck portion are flannel-lined for comfort. Sole and heel of boots are reinforced with asbestos brake lining material, riveted in place for durability, long wear, and protection.

The suit is made in a universal size only, with tabs at each side and back to adjust length.

PHOSPHORESCENT

Material In Sheet Form For Blackouts

A FABRIC sheet with a phosphorescent coating on one side is now available in rolls under the name Conti-Glo P-10. The material can be cut from its sheet form into strips and used to outline objects and obstructions so that they can be seen in the dark. For example, long strips may be applied to the side of a stairway or along the wall of a room. Shorter strips may be used on the stair risers.

The material resembles oilcloth in appearance and can be secured to any surface by tacking, by the use of adhesive tape, or by cementing in place.

RESPIRATOR

Keeps Out Dust, Can be Used with Inhalant

WEIGHING only half an ounce with its filter pad in place, a new respirator is useful in industry as well as in the treatment of certain respiratory ailments.

This respirator, announced by Allergy and Medical Products, Inc., and shown in one of our illustrations, is reported to be very comfortable to wear. This is due to its light weight,

Weighs little, has many uses

plus the fact that the frame of the mask is composed of a thin sheet of metal which can be molded to the contour of the face and which is held in place by an adjustable head band.

A wire frame, attached to the bottom of the mask, holds the replaceable filter pads away from the nose and mouth, thus giving a large breathing area.

For ordinary use where it is desired to keep dust from the respiratory tract, plain untreated filter pads are employed.

For treating colds and other respiratory infections, a few drops of an effective inhalant are dropped on the filter pad, enabling the patient to bathe his membranes continuously with the soothing vapors.

STORED CARS

Need Complete Protection Against Deterioration

"UNLESS you are prepared to take the necessary precautions, it may be thriftier to drive your car sparingly than to put it in storage for the duration," says T. H. Stambaugh, director of national service operations for the Hudson Motor Car Company, and continues:

"If a car is stored for a year or two without precautions, it is doubtful if it can be put back in operation without a major repair job. In addition, the owner is likely to find that his tires have deteriorated, the battery is ruined, and the car's finish is damaged.

"I have no quarrel with—in fact, I commend—those individuals who want to store their cars for patriotic reasons. Nor will I argue about possible savings in gasoline and oil if cars are taken off the road. However, preservation is one thing and waste is

another. To preserve, we will have to go the full way through preparation to make preservation a practical thing and not just a theory.

"Persons who are considering storing their cars for the duration to save tires should consider the fact that tires deteriorate when not in use. This is because normal operation of a car flexes the rubber and keeps it alive. Light—even artificial light—damages stored tires. All windows in the storage place should be blacked out and the car should be blocked up to remove the weight from the tires. Even then, there should be a certain amount of inflation during the storage period, calling for periodic checking.

"When a car is placed in storage, all gasoline must be drained and then a half pint of mineral spirits, naphtha, or benzine must be run through the pump, carburetor, and engine to remove every last vestige of gasoline. If this is not done, gum accumulates, and the valves may stick so tightly that they may have to be literally 'hammered loose' from the guides.

"Before this is done, the oil in the engine should be changed to a very high grade product and the engine run for 5 minutes. Then 2 ounces of a high grade No. 10 motor oil should be injected in each spark plug hole and the engine turned over several times with the starter, so that rings and cylinder walls will be thoroughly covered with a protective coating. Failure to take this precaution may mean that when the engine is started after a long period of storage the rings may be 'frozen' in the cylinders, and great damage could be done the engine when attempts were made to start it after the storage period is over.

"The radiator should not be drained, because moisture remaining in the cooling system could start rust formations. The cooling system should be kept up to full level at all times. A rust inhibitor should be added to the coolant and if there is danger of freezing temperatures, anti-freeze should be added.

"To prevent rusting, springs, frame parts, clevises, and other chassis parts should be sprayed with motor oil. All bright finished parts must be treated with paraffin wax after rust spots, if any, have been removed.

"To prevent deterioration of the lacquer, the car finish should be thoroughly washed, cleaned, and waxed.

"Upholstery should be thoroughly protected from moths with a minimum of four one-half pound cakes of naphthalene when placed in storage, and every 60 days thereafter with one half-pound cake. Openings around foot pedals should be protected with screening or metal to keep out rats and mice. The body should be air-tight through closing all doors, windows, and ventilators, so that the naphthalene can do its work.

"Batteries deteriorate and should be stored where they can be charged regularly and the solution kept at the proper level."

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TRAIN—The hobby of playing with toy trains now has more than 100,000 American men enthusiasts, who have invested at least $10,000,000 in their equipment and support three hundred local clubs, three magazines, and a national association which holds annual conventions. One millionaire even has one of these miniature railroads installed in a Wall Street building, where it occupies two entire floors.

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FOREST RADIO

Antenna Needs No Insulation

ONE of the new devices for use in emergency radio communication, now aiding the United States Department of Agriculture's Forest Service in the current and continuing fight against fires, is a simplified radio antenna perfected recently at the Forest Service's Radio Laboratory.

The new forest radio antenna has no insulators, requires no elaborate installation, and can be pre-tuned before installation. Costing but a small fraction of what the usual commercial antenna costs, it is called the PD ("plumber's delight") antenna by forest rangers because it can easily be made from simple materials like pipe and fish poles and installed with the aid of a few plumbers' tools. The fact that no insulation is necessary prevents power losses and reduced efficiency due to insulator leakage. Resistant to snow and ice, the antenna is especially suitable for lookout stations at high elevations.

It is equally effective on wood and metal buildings. Another asset is that instead of representing a lightning hazard, it acts as a lightning rod, adding to the safety of the structure to which it is attached and of the occupants. Reduced to barest essentials, the PD antenna consists of a vertical radiator, working against a ground established by four horizontal quarter-wave radials. For Forest Service radio frequencies, the antenna is only six to seven and one-half feet long.

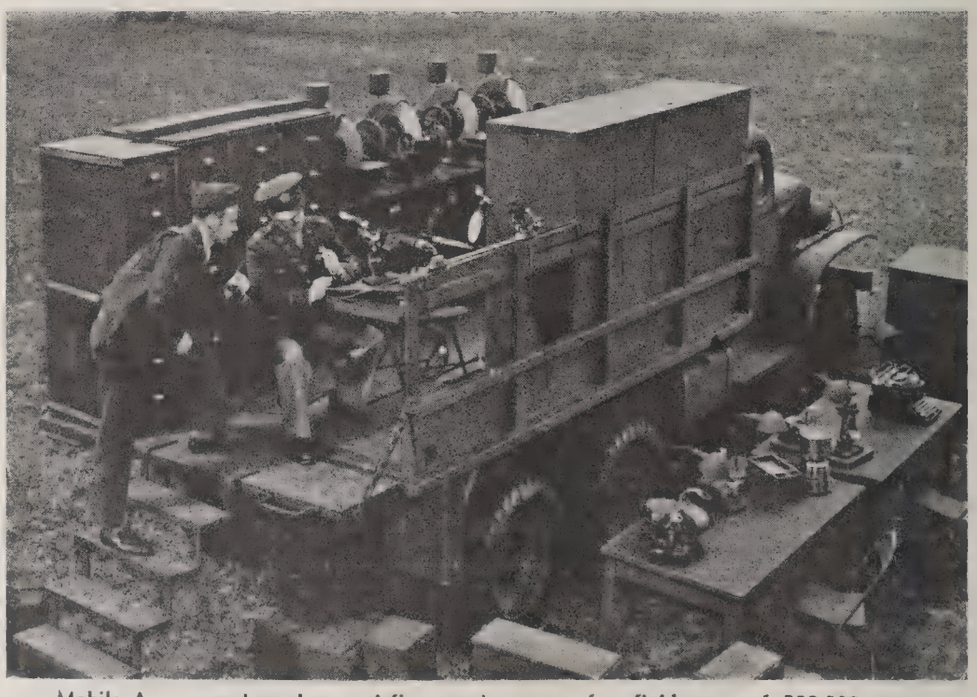
MOBILOPSHOP

Army Spectacle Wearers Have Fewer Worries

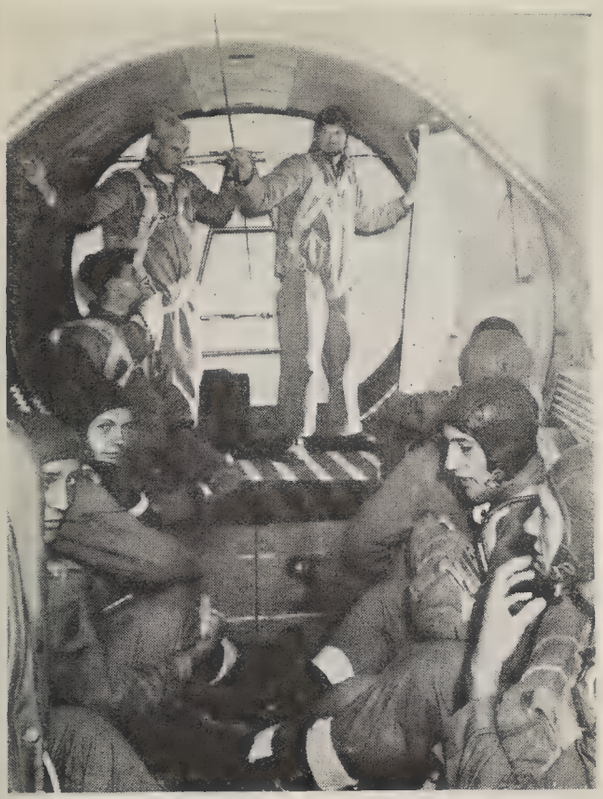
OVERSEAS soldiers who break or lose their spectacles in camp or on the battlefield will have them repaired or replaced in the field by mobile optical shops, first of their kind to be attached to United States field armies.

The first of these units, built by the American Optical Company, and commanded by Captain J. R. Harrison, was designed at the request of the Surgeon General's office. It contains optical machinery, 36,000 lenses, 8400 frames, 600 pairs of extra temples, and 1200 spectacle cases. A total of 120 single lenses can be edged and mounted daily, which is estimated to be sufficient for the average requirements of a field army of 300,000 men.

Approximately 15 percent of the men in the armed forces wear glasses. In World War I an optical shop was set up for the A.E.F. in a suburb of Paris. As it was stationary, speedy



Mobile Army eyeglass shop satisfies requirements of a field army of 300,000 men



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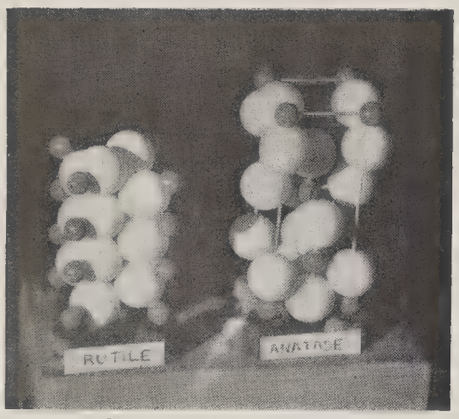
spectacle service to the soldiers in the field was impossible. A member of the present editorial staff of this magazine, whose glasses were broken in line of duty, was forced to journey to a distant city, find a French optician's shop, and pay for the replacement from his own pocket.

In the present war each soldier who wears glasses will have a copy of his prescription attached to his service record at the headquarters of his respective organization. When he needs glasses, he applies to headquarters for the necessary authorization, after which the optical unit swings into action. Thus, today, they are doing things better.

IT'S IN THE CRYSTAL

New Form of Paint Pigment Covers Better

THE patterns of the crystals composing titanium dioxide—the whitest white substance man has yet found for making and keeping white paints white—are physically at considerable variance. One of the three known



Pigments that go farther

types of titanium dioxide crystals is as compact as a clenched fist; the titanium and oxygen atoms in one of the other crystals are arranged in an open, loose fashion. Herein lies a minute difference of mighty significance.

This pair of titanium dioxide crystals—left to right, in the picture—are known as rutile and anatase. Rutile, the chunky fellow, is a newcomer. After ten years of research, the Krebs Pigment & Color Corporation, E. I. du Pont de Nemours & Company, Inc., is now able to make its whiter-than-white titanium dioxide pigment in the form of rutile crystals.

Previously the pigment that revolutionized the formulation of white paints came in the form of anatase titanium dioxide—which had more than double the hiding power of any previously available white pigment. Now, with white pigment available in rutile form, hiding power is increased another 25 to 33 percent. To put it in another way, a rutile enamel can be used to cover one third greater area than an anatase enamel without any increase in the "show-through" of the background. The manufacturer can make four gallons of paint with "Ti-Pure" R—the official name for the new rutile form titanium—where he could only make three with the anatase grade. And this is all due to the fact that the compactness of the new rutile crystal affords a higher index of refraction—or hiding power—than any other titanium pigment available today. Rutile titanium, in the language of the paint-maker, means more "covering power"—greater mileage for enamels and lacquers as well as white paints.

■ ■ ■

POWER—Start of long-distance transmission of electric power was recently recalled when the world's first alternating current waterwheel generators at Niagara Falls were returned to service for the duration of the war. Built in 1896, these 10 machines had been retired for 17 years as stand-by equipment. They were installed in the Edward Dean Adams Station at Niagara Falls, by Westinghouse, 45 years ago to produce the power which was sent over wires to Buffalo, New York, 20 miles away.

● ● ●

ROAD CORRUGATIONS

Caused by Air, According to New Theory

IN a paper reported in *The Journal of the Institution of Engineers*, Australia, Alan Price recently discussed the cause of road corrugation on certain types of paved and unpaved surfaces. He states that it is a mistaken idea that corrugation results from the frictional action of motor car wheels. He points out that, if this were so, the corrugations would occur only adjacent to the wheel tracks, whereas actually they are found to extend right across the road width, and he postulates the theory that they are the direct result of air currents produced by the motion of the car.

Observations and experiments are quoted by Mr. Price to show that wind, or air currents, have wavelengths which eventually bring about "heaps" or corrugations at right angles to the directions of flow; in the case of a road, however, these corrugations do not occur exactly normal to the center line, but lie slightly forward from left to right. The reason for this latter phenomenon is that the air stream is not running parallel to the center line, because the camber of the road induces the current to follow the line of least resistance and to swerve somewhat to the left; this results in two sets of corrugations—one on either side of the pavement—parallel to each other, but frequently breaking step at the center, making this generally the most uncomfortable portion of the road on which to travel.

BLAST CUSHIONING

Glass-Fiber Panel For Factory Blackouts

A NEW blast-cushioning, incombustible glass-fiber material for blacking out war-production plants is designed to reduce damage from concussion and to provide protection against the spread of fire caused by incendiary bombs or explosives.

Known as Fiberglas OC-9 Board, the new material is composed of fine, resilient glass fibers compressed and treated with a binder which gives it sufficient rigidity to serve as a self-supporting, fire-resistant material. The material can be faced with glass-fiber cloth, plywood, or other surfacing materials.

Experience in England has shown that even fairly distant bombing may prove highly destructive to industrial operations by shattering windows, scattering death-dealing glass fragments, and disrupting delicate instruments. Although the concussion-absorbing qualities of the compressed glass fibers cannot provide complete protection against nearby blasts, the resilient, light-obscuring and protective materials may prove of definite value by absorbing part of the concussion caused by explosions.

A recent demonstration of this panelling was the first showing of the

Reduces damage from bomb concussions

use of glass-fiber materials for blacking out existing industrial plants. Large quantities of glass fiber products were, however, used for heat insulation and sound absorption in the fire and shatter-resistant walls, and the fire-resistant roofs, of two huge blackout bomber assembly plants already built.

RISKY

Black Widow Spider

Menace is No Joke

In the "Annals of Surgery," Dr. H. T. Kirby-Smith cites evidence that privies are a major menace because they so often harbor the highly venemous *Latrodectus mactans*. As abstracted in *The Journal of the American Medical Association*, his findings show that bites by the black widow spider occur more frequently than is generally supposed. He has collected 15 cases from the records of the Vanderbilt Hospital and has encountered nine cases during five years of private practice. Fourteen of the 24 patients actually saw the spider, and the history and subsequent course of symptoms of the other 10 leave no doubt that they were bitten by the black widow.

Eleven of the bites were on the penis, four on the buttocks, one on the scrotum, one on the thigh, four on the arms and hands, one on the chest, one on the knee, and the site of one was not mentioned.

Sixteen of the victims were bitten while in a privy. Twenty-two of the patients were male. Symptoms ensued from 5 minutes to two and a half hours after the bite. The bites were inflicted from April through October. There was 1 death. Death following a bite by a black widow spider is uncommon.

SPRAY CHECK

Makes Possible Rapid

Study of Insecticides

A precision sprayer and duster devised by scientists at the New York State Experiment Station, which make it possible to deposit fungicides on one half of an apple leaf, leaving the other half as a check, are aiding in more rapid evaluation of the effectiveness of new spray materials for the control of orchard diseases.

"In the orchard," say the Station specialists, "the environment must be accepted as it is without control and the complexity of factors that affect the results make it difficult to come to any definite conclusions. Also, years of experimentation may elapse before conditions suitable for certain phases of a study are encountered. Orchard trials will always remain the final test of effectiveness of spray materials, but laboratory and greenhouse procedures which duplicate orchard conditions most closely provide a rapid and economical method of testing new fungicides, and also open up possibilities for much fundamental research about fruit diseases and their control."

Three different types of precision sprayers have been designed. For the most rapid testing of fungicides, particularly sulfur, glass slides are sprayed with the materials under test and the spore suspensions of the desired fungus are applied to the slides to determine the comparative values of different sprays. More reliable tests on foilage grown in the greenhouse are made with a horizontal type of sprayer which makes it possible to spray one half of a leaf, leaving the other half as a check.

To duplicate orchard conditions, a small model orchard sprayer has been set up in the laboratory. This does not give as accurate control as the precision sprayers, but very uniform and reproducible coverage is obtained by placing the potted trees on

A New Star over America

THIS is the new All-Navy "E" burgee. With its added star, it signifies that, for a period of over six months, production of Navy material has been apace of schedule. First flown in America over the Bausch & Lomb plant, it is official Navy recognition to B&L workers of their continued achievement in Production for Victory. It replaces the Bureau of Ordnance flag and "E" pennant awarded Bausch & Lomb July 25, 1941.

The Navy "E" has always been an honor to be striven for, to be guarded jealously. On gun turret, battleship funnel, or the flagstaff of an industrial plant, it is a symbol of championship performance. But today, Navy officials—and the American public—are anxious to see this award in as many places as possible. Because "championship performance" is what America needs today—all down the line.

Workmen at Bausch & Lomb are devoting to the specific implements of war, the experience and skills gained in the production of scientific optical instruments. Today the world depends on America's men-behind-the-men-behind-the-guns to destroy the forces of aggression—that the ideals of individual freedom may survive.

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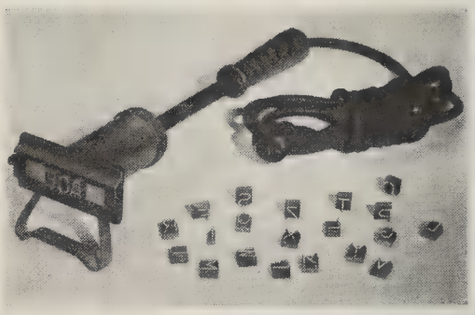
a turntable and passing them through the spray for a definite period of time.

BRANDING TORCH

For Tires, Protects Against Theft

FLEET owners and garage men are finding plenty of use for a tire branding outfit which has recently been made available and which can



Identifies your tires

go far toward preventing tire thefts. This branding torch, illustrated in these columns, is heated electrically, the heat being transferred to interchangeable letters which are firmly fastened in the slotted face of the tool.

■ ■ ■

SUGAR—A single acre of sugar beets produces, according to the United States Beet Sugar Association, approximately 3100 pounds of granulated sugar, as well as enough by-products for feed to produce 253 pounds of beef or lamb.

● ● ●

END BRUSH

Designed to Clean Welded Joints

A POWER-DRIVEN end brush, made by The Osborn Manufacturing Company, is designed particularly to facilitate the cleaning of slag, scale, or oxidation from welds on inside corners, as well as in other locations which are

Brushes hard-to-get-at welds

difficult of access. It is claimed that this new brush will get into any space which is accessible for welding; it takes no more room to manipulate the brush than it does to weld. The brush can be used in all standard power tools, whether air or electric.

FUMIGANT

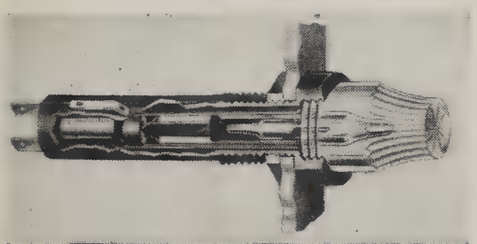
Kills Insects in Grain and Flour

A NEW fumigant for grain and flour, highly penetrating and deadly to insects but harmless to humans, is announced by the University of New Hampshire. The compound, chlorinated nitroethane, is a clear liquid with a distinct but not disagreeable odor, stated to be safe to ship in ordinary containers. It evaporates readily on exposure to the air, and the fumes penetrate quickly even into large masses of grain or flour. A simple method of fumigating grain in cars consists of putting the chemical on top of the grain and then sealing the car.

INDICATOR LIGHT

Gives Visual Indication Of Circuit Break

A SMALL panel indicator light which goes on only when an electrical current is broken is now finding use in railroad signalling equipment, in air-



Operates only when circuit is broken

craft applications, and in many other circuits where a remote indication of trouble is desirable.

When this indicator light, manufactured by Littlefuse, Inc., is installed at any convenient point in connection with a remote control setup, it works instantly, giving a plainly visible signal. The lights are available either with filament bulbs or neon lamps which will glow on currents as low as 100 microamperes.

INTER-AMERICAN

Highway Now More Than Half Completed

LINK by link, the great Inter-American Highway is being built from the United States through Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama to South America. Approximately 3,500 miles of all-weather surfaced road is involved and more than half of it is already completed and open for travel, although the completed segments are not all continuous.

The longest section of the Inter-American Highway which has been opened to automobile travel to date is a stretch of over a thousand miles extending from Laredo, Texas, through the greater part of Mexico. Most of this section is surfaced with asphaltic materials. It was actually started some 15 years ago. Each of the Central American countries has constructed an extensive strip of the highway but shorter lengths remain to be finished. Guatemala was the first to improve its entire mileage (300) for all-weather travel. Impassable trails still exist at certain points along the route through Central America. However, completion is now within sight.

Effect of the new highway will be far reaching. Tourists will find within easy range the historical land of the Aztecs and the early Spaniards, the floating gardens of tropical lakes, and the snow-covered volcanos of continuous mountain ranges.

From the standpoint of business the highway will be especially important because it will open up rich producing regions of rubber, wool, hard rice, tea, cinnamon, camphor, coffee, quinine, copra, oils, varnish gums, abaca hemp, and many other commodities including rare woods.

The Inter-American Highway is being financed by the United States and by all the countries through which it passes. Its construction utilizes the latest tools of the modern world. A

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PRECISION
FROM START TO FINISH
War production demands precision from start to finish—from toolroom to production shop. Without precision, the vast quantities of war supplies so urgently needed could not be produced in time—for efficient mass production is based on a degree of precision which permits the perfect interchangeability of thousands of duplicate units.
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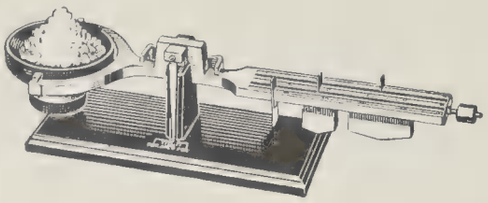

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material is readily made from paper that otherwise might be baled and sold, thus obviating the necessity of purchasing new packing material. The shredding knives in the machine are made of hardened tool steel which, it is claimed, will cut light metal such as paper clips, staples, pins and so on, without injury to the cutting edges.

PSYCHIC VACCINATION

Rats Made Immune to Noises by Other Noises

PSYCHIC "vaccination" against the nerve-shattering effects of war noise is a future possibility, it is suggested by a report recently made to the Mid-western Psychological Association. Noise-sensitive rats that ordinarily would be thrown into fits similar to epileptic seizures by certain shrill or irritating noises have been made immune to the seizure-producing sounds, according to Dr. Norman R. F. Maier, of the University of Michigan. The immunity lasted for several days.

The protecting treatment consisted merely of preceding each seizure-producing noise with another to which the rat is not sensitive. Continuation of this procedure with daily tests for

about two weeks makes it possible to expose the rats to the seizure-producing sounds without harm. After a week without tests, the animal is again susceptible.

The noise-induced seizures in rats are due, Dr. Maier concludes, to nervous tensions, and if enough preparation is given, the organism can adjust. In states of low energy the tensions are not sufficient to break through and get control of the animal.

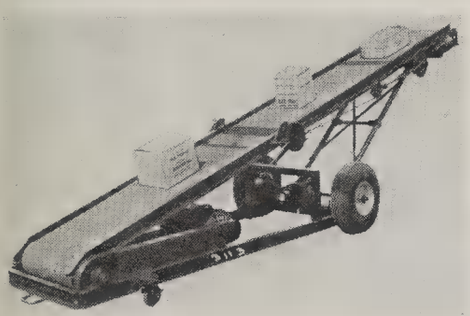
Just how closely the noise-induced fits of susceptible rats resemble the jumpy, jittery nerves produced in some humans by the explosive blasts, shrieking shells, and roaring dive bombers of modern war is not yet known to psychologists. But the fact that a means has been found for protecting the rats by this sort of psychological immunizing process raises hope that some similar method may be developed for helping humans to protect their nerves against war damage.—*Science Service.*

CONVEYOR

Portable Unit Has Variable Incline

A PORTABLE conveyor for use in piling boxes, bales, and other materials, illustrated in one of our photographs, is provided with rubber tired wheels which make it possible to move the machine from one site to another by simply hooking the lower end of it to a motor truck.

The belt on this new conveyor rides on rollers mounted in a structural frame that is hinged to a supporting frame so that the discharge end may



For piling, loading, and unloading

be raised and lowered from a minimum of four feet to a maximum of eight feet. Elevation of the unit is accomplished by a hand crank and geared drums.

The belt of the conveyor is driven by a motor and speed reducer with chain connection to a pulley at the lower end. Adjustment of the belt is accomplished through an idler pulley at the upper end. This unit, known as the Portable Belt Piler, is manufactured by the Standard Conveyor Company.

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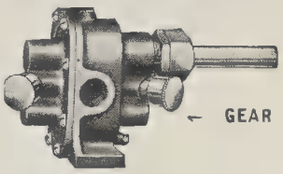
BRONZE GEAR AND CENTRIFUGAL PUMPS



		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	1/4"	1/8"	$ 6.50	$25.00
No. 4	"	3/4"	1/2"	13.50	32.00
No. 9	"	1 1/4"	1 "	16.50	35.00

No.	1 1/2 Gear	1/8"	Price	$ 9.00	With A.C. motor	$25.00
No.	2 "	1/4"	"	10.00	" " "	27.50
No.	3 "	3/8"	"	11.50	" " "	28.50
No.	4 "	1/2"	"	12.50	" " "	32.00
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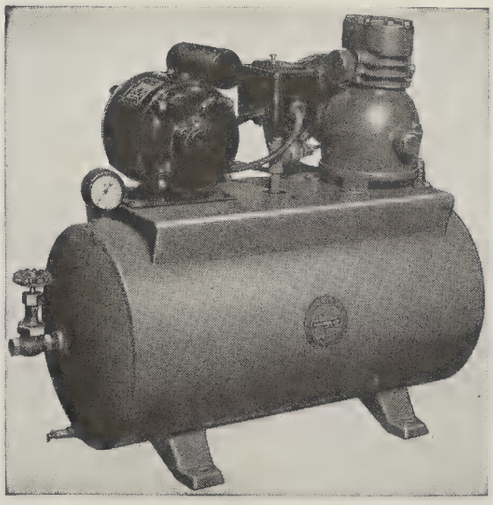

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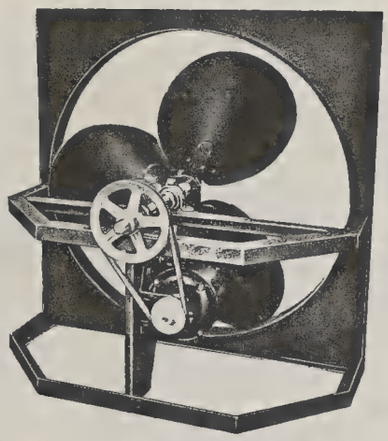

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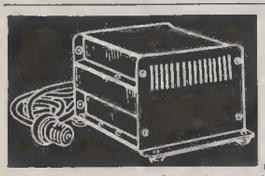
36"	1/4	415	8000	57.50
42"	1/3	390	11500	69.50
48"	1/2	360	16500	92.50

MAGNETIC GAS VALVES

All sizes in stock; Prices on request



COROZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC. Only 10 watts. $9.50

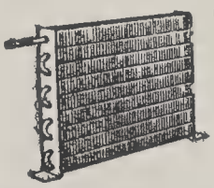
DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	$1.10	20 Amp.	$3.15
3 Amp.	1.65	35 Amp.	5.50
5 Amp.	1.65	65 Amp.	11.00
10 Amp.	2.00	200 Amp.	50.00

Synchronous Motors

New Emerson 100th H.P., 900 R.P.M. 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base. Has many applications.. $7.50



"BUSH" CONDENSERS TINNED COPPER

Designed for refrigeration and air conditioning. Has many other uses. High heat transfer capacity and great efficiency.

Sizes 7 3/4 x 12 1/2 ..... $3.25 each

Sizes 9 3/4 x 11 3/4 ..... 3.50 "

Limited number of larger sizes on hand.

EXHAUST FANS, BUCKET BLADES

General Electric A.C. 110 volt motors.

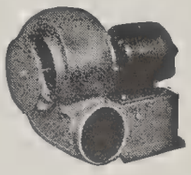
	R.P.M.	cu. ft. per min.	Price
9"	1550	550	$12.00
10"	1500	550	13.50
12"	1750	800	18.00
16"	1750	1800	21.00
16"	1140	1650	27.50
18"	1750	2500	22.50
18"	1140	2100	32.00
20"	1140	2800	36.00
24"	1140	4000	42.00
24"	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.

FORGED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4 1/2"	3 3/4"	$22.00
0 1/2	1/8	1750	350	6 1/2"	3 3/4"	25.00
1	1/6	1750	535	6 "	4 1/2"	30.00
1 1/4	1/4	1750	950	7 1/2"	6 "	37.50
1 1/2	1/2	1750	1900	9 1/2"	7 "	75.00

PRICES QUOTED ARE FOR A.C. 110 V. 60 CYCLES ONLY. OTHER VOLTAGES ON REQUEST.



PIONEER AIR COMPRESSOR CO., Inc.

120-s CHAMBERS ST. NEW YORK CITY, N. Y.

What Strange Powers Did the Ancients Possess?

EVERY important discovery relating to mind power, sound thinking and cause and effect, as applied to self-advancement, was known centuries ago, before the masses could read and write.

Much has been written about the wise men of old. A popular fallacy has it that their secrets of personal power and successful living were lost to the world. Knowledge of nature's laws, accumulated through the ages, is never lost. At times the great truths possessed by the sages were hidden from unscrupulous men in high places, but never destroyed.

Why Were Their Secrets Closely Guarded?

Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious silent something which "whispers" to you from within.

Fundamental Laws of Nature

Your habits, accomplishments and weaknesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental as the laws of breathing, eating and sleeping. All fixed laws of nature are as fascinating to study as they are vital to understand for success in life.

You can learn to find and follow every basic law of life. You can begin at any time to discover a whole new world of interesting truths. You can start at once to awaken your inner powers of self-understanding and self-advancement. You can learn from one of the world's oldest institutions, first known in America in 1694. Enjoying the high regard of hundreds of leaders, thinkers and teachers, the organization is known as the Rosicrucian Order. Its complete name is the "Ancient and Mystical Order Rosae Crucis," abbreviated by the initials "AMORC." The teachings of the Order are not sold, for it is not a commercial organization, nor is it a religious sect. It is a non-profit fraternity, a brotherhood in the true sense.

Not For General Distribution

Sincere men and women, in search of the truth—those who wish to fit in with the ways of the world—are invited to write for a complimentary copy of the booklet, "The Mastery of Life." It tells how to contact the librarian of the archives of AMORC for this rare knowledge. This booklet is not intended for general distribution; nor is it sent without request. It is therefore suggested that you write for your copy to the Scribe whose address is given in the coupon. The initial step is for you to take.

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The Rosicrucian Order
San Jose, California. Please send copy of sealed booklet, "The Mastery of Life," which I shall read as directed.

Name.....

Address.....

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—NATIONAL DEFENSE—

SEA NESTS FOR WAR BIRDS

By Walton L. Robinson

Continued from page 54

5-inch guns are of a new model and can be used with equal effectiveness against warships or aircraft. They comprise the main armament of all our modern destroyers and of the four 6000-ton light cruisers of the speedy *Atlanta* class, which are now joining the fleet. They also constitute the secondary battery of the new battleships *North Carolina* and *Washington*.

Maximum aircraft capacity of each of these carriers is over 100 planes, but in normal service the *Enterprise* accommodates 81 aircraft—a 75-plane Air Group and 6 utility planes. Her combatant aircraft comprise one squadron of torpedo planes, one of bombers, one of fighters, and one of scouting planes. The *Yorktown*, flagship of Aircraft, Battle Force, Pacific Fleet and Carrier Division Two, has the same aircraft complement plus a four-plane Flag Unit. One of the most interesting features about these ships is their ability to catapult their aircraft from the hangar deck as well as from the flight deck. This is a great advantage, for it increases the number of planes which can be put into the air at short notice.

The *Yorktown* and *Enterprise* are much more stoutly armored than the *Ranger*. They have a heavy protective deck and a patch of side armor, unofficially reported to be four inches thick, over machinery and boiler spaces, and the usual internal sub-division. They are also very fast—the fastest carriers in our Navy and probably faster than any foreign ones. Their 120,000 horsepower geared turbines, driving four propellers, give them a designed speed of 34 knots, which they have exceeded on trials. Steam is supplied by nine Babcox and Wilcox express type boilers.

In general appearance these ships bear some resemblance to the *Saratoga* and *Lexington*, though they can easily be distinguished from them. They have a fairly large flat-sided funnel, tripod mast, and considerable island superstructure on the starboard side of the flight deck, but no gun-houses such as in the older and larger carriers. In peace time it was possible to differentiate between them by the large black "Y" painted on both sides of the *Yorktown's* funnel.

The 14,700-ton *Wasp*, laid down April 1, 1936, by the Bethlehem Steel Company and commissioned four years later at a cost of nearly $21,000,000 (exclusive of armament and aircraft), is a smaller edition of the *Yorktown*

with certain features of the *Ranger's* design. Her hull lines closely follow those of the *Ranger*, but her superstructure, save for her smaller funnel, resembles the *Yorktown's* in general arrangement. On the water-line the *Wasp* is 688 feet long and 80 3/4 feet wide and in a light condition draws 20 feet. She is, therefore, 40 feet shorter than the *Ranger*, but slightly wider and deeper in the water. Her over-all length is 739 feet. This is also the length of her flight deck, which extends beyond the over-hanging bow and stern. Her armament is the same as the *Yorktown's* and her protection generally similar to the *Ranger's*.

The *Wasp* carries two squadrons of scouting planes, two of fighters, and six utility planes—a total of 84 aircraft. Her engines, Parsons geared turbines, develop 55,000 horsepower for a designed speed of 30 knots.

America's newest regular carrier, the $32,000,000 *Hornet*, was commissioned last October—some months ahead of schedule. She was laid down September 25, 1939, and launched December 20, 1940, by the Newport News Shipbuilding Company. Details concerning her are restricted, but it is known that she is a modification of the *Yorktown* design, incorporating a number of improvements. Her water-line length has been reported at 770 feet and her displacement at over 20,000 tons. From photographs it is evident that she varies only slightly in appearance from the *Yorktown*. Most of this difference is to be found in the island superstructure.

Our eleven carriers under construction or on order are expected to be ships of around 25,000 to 26,500 tons and to cost in the neighborhood of $60,000,000 each. The *Essex*, *Bon Homme Richard*, and *Cabot* are scheduled for completion next year, while most of the others will follow in 1944-45. They will be welcome additions to our Navy in its life-and-death struggle in the Pacific and in its efforts to assist Britain in maintaining the vital lines of communication in the North Atlantic.

● READERS of the accompanying article on aircraft carriers, and of other articles on naval matters in monthly magazines, must always bear in mind the time-element involved in the publishing business and in the release of information by the Government to writers and editors. Thus, Mr. Robinson's article was written and set in type after the Battle of the Coral Sea, but before the details of that battle were released. Hence it will be understood why the carrier "Lexington" is written of as a ship in being, whereas she actually was destroyed as a result of that engagement.—The Editor. ●

EDISON STORAGE BATTERIES

Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150	Ea.	$6.00
A-6	Amp. Hrs. 225	Ea.	6.00
A-7	Amp. Hrs. 262	Ea.	7.00
A-8	Amp. Hrs. 300	Ea.	7.00
B-2(J-3)	Amp. Hrs. 37	Ea.	5.50
M-8	Amp. Hrs. 11	Ea.	2.00
L-20	Amp. Hrs. 13	Ea.	2.50
L-40	Amp. Hrs. 25	Pr.	4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells..... $5.95

U. S. ARMY TELEGRAPH SOUNDERS

All brass on wood base, 20, 50, or 200 ohms, Bunnell..... $4.95

TELEPHONE SWITCH DIALS

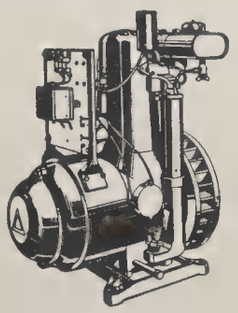
"Kellogg" 4 terminal, 10 digits. Diameter 2⅞", new $3.50

Lighting Plants, New

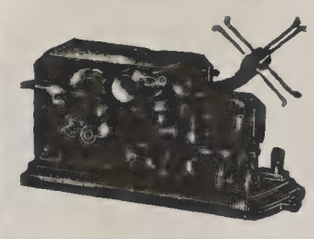
Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.



TELEGRAPHIC TAPE RECORDER



Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. **Double pen permits simultaneous recording of two messages. Pens** operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms. Rebuilt & finished,

like new $47.50 Reconditioned $30.

GLASS MERCURY TUBE SWITCHES

3 amp. ..... $1.25 10 amp. $2.25
6 amp. ..... 1.95 20 amp. 2.95

TRANSMITTING CONDENSERS MICA

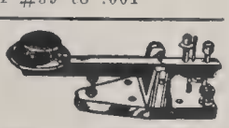
operating volts 12,500, cap. 004.
Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8,500, cap. 004 .....$7.50

NICHROME WIRE

in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95



Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound	$18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound	15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound	10.50
Schwarze 8" 100 Ohm 32 volt	10.50

Build Your Own Searchlight

U. S. Army Parabolic Mirror

Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	8 in.	¼ in.	$15.
30 in.	12½ in.	7/16 in.	75.
36 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand.

BAROGRAPH, FRIEZE, 7 Day Graphic, 7 Jewel movement, 28 in. to 31 in. atmos. pressure by 20th. 8 Vacuum Cylinders 3⅝ in. dia. hinge cover, glass front, mahogany case. Price $55.00

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb. Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. ARMY LIQUID COMPASS (Sperry)

Bronze jewel bearing. Leather case. 2⅜" diameter, 1¼" high $2.50

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills $27.50
24-1000 Gen. Elec. 1000 mills $50.00

12-350 volt 80 mills	$18.00
12-750 volt 200 mills	30.00
32-350 volt 80 mills	9.00
32-300 volt 60 mills	7.50

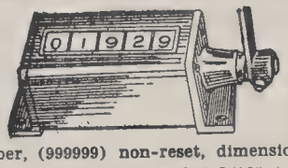
U. S. ARMY ALIDADES

Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. $1.95
45° angle adj. type, made in France

HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veedor-Root" Revolution Counter



Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ¾ inch wide $2.00

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

TUNGSTEN CONTACT DISCS

1⅜" dia. — 1/16" thick. Pure metallic tungsten contacts. Machined and polished $2.00 ea $3.00 per pair.

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Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

BRAZING

With Induction-Heating Equipment

SKILLED labor is not necessary for the operation of a new induction-heating unit for brazing assemblies of various types. The unit shown in one of our photographs was designed to braze a steel tube and a steel hexagon head, but the effectiveness of this particular job may suggest other brazing or metal-treating operations which will facilitate production and decrease labor and material costs.

The equipment used in the unit shown, manufactured by the Induction Heating Corporation, consists of

Skilled labor is unnecessary

a high-frequency generator of 20-kilowatt rating and a double seven-place heating coil. With this double unit, seven working assemblies are heating or cooling on one side while seven others are being removed or set up on the other. A silver brazing alloy is used which penetrates quickly through the joint, the resulting strength of the joint, it is claimed, being as high as or higher than the solid parts.

STICKERS

For Identification, Are Easily Removed

A NEW type of dry sticker having a special adhesive substance that makes it particularly adaptable for use in defense plants is being used for inspection, rejection, instruction, and identification purposes where speed and accuracy are important. Sold under the trade name of Kum-Kleen Stickers, it is claimed that they overcome many of the disadvantages of ordinary labels, tags, and markings. They are applied quickly, without moisture, on any smooth surface, including polished metal, glass, and plastics, simply by a slight finger pressure. Unaffected by intense heat, cold or humidity, they stick permanently, though they may be peeled off easily by hand without leaving a stain or mark.

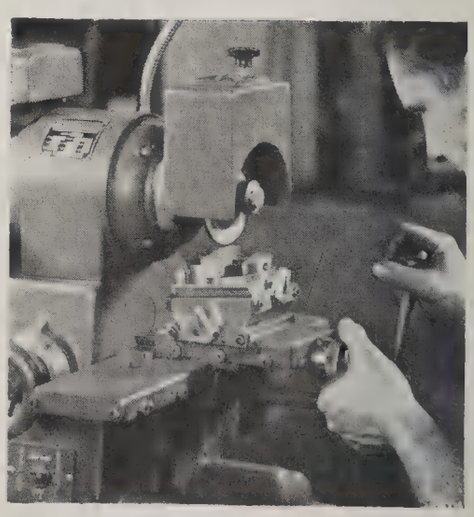
ANY ANGLE

Tool Vise Can be Firmly Locked in Position

COMPLETE in itself, a new tool vise that can be locked firmly at any angle is mounted on a lug base which is easily affixed to a machine table.

The vise, designed particularly for tool grinding, is constructed on a double-cradle principle permitting adjustment of grinding angles on three separate planes. Two closely machined steel blocks, rounded on the bottom, are cradled into each other at right angles. After adjustment, they are solidly locked together by tightening cam locks operating in machined segments at ends of the respective blocks. Mounted atop these two blocks is a flat, circular piece which swivels 90 degrees from center of any of the four sides of the block immediately below. This piece carries the vise jaws, holding tools firmly by means of Allen screws.

The principle of closely fitting steel blocks which may be tightly locked together permits of absolutely no vibration or deflection, thereby insuring maximum accuracy of the grinding



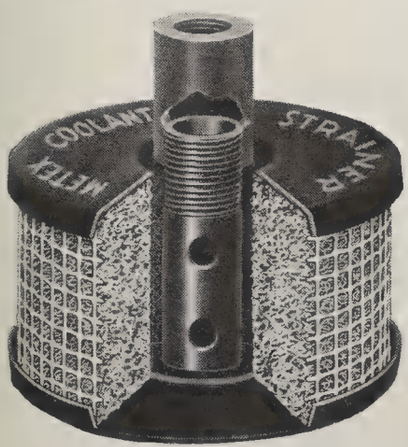
Universal positions for tool-grinding

angle selected. Readings on each block are clearly marked. Each tilts 15 degrees either way from horizontal, and this adjustment, combined with 360 degrees selectivity of the circular piece at top, provides almost any angle desired. The vise has been placed on the market by Hammond Machinery Builders, Inc.

COOLANT STRAINER

Strains Chips and Cuttings from Fluids

For machines which require the use of a coolant, a new strainer has been developed which removes metal chips and cuttings remaining in suspension, permitting only chip-free cooling solution to pass through the pump. This



Saves production interruptions

strainer, made by Metal Textile Corporation, is claimed to save general wear and tear on pumps, to conserve coolant, and to increase production speed. Tests of the strainer reveal that on "dirty work" machines, operations can be continued without interruption for four to six weeks before cleaning of the strainer is necessary.

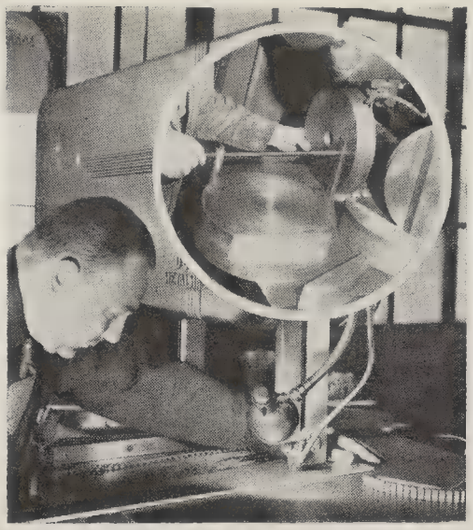
BAND SAW

Cuts Steel As If It Were Cheese

Metal-cutting band saws that will cut 18-inch thicknesses of the toughest die steel at a rate of six and one-half linear inches per hour have recently been developed for contour sawing. The specialized equipment used for this purpose has been designed through constant research on band saws and their cutting edges. Progress in this work has extended to a point where, it is claimed, a 3/32-inch wide saw can now be produced with about the same relative cutting efficiency as a half-inch saw.

One of our illustrations shows one of these new metal-cutting band saws developed by Continental Machines, Inc., in use shaping airplane parts. The inset picture shows a saw notching a 12 inch by 3 inch machine part. The saw illustrated will cut one-inch tool steel at a rate of 140 inches per hour.

The process of contour sawing with these new and efficient band saws per-



For shaping as well as for notching

mits shaping of the most complicated outlines in almost any material used in any industry. Aside from saving a considerable amount of time over conventional or basic cutting machines, contour saws make it possible to save practically all material not actually used to produce the parts being shaped or formed.

ELBOW

For Plumbing Use Made of Plastic

Critical metals are again conserved in the plumbing trade by a new flush elbow for connecting the tank to water closets. The problem has been efficiently solved, and an advance has been made in material adapted for the purpose, in one-piece molding of the flush "L" in tough resistant plastic, by American Molded Products Company.

This "L" is an elbow connection of tank and bowl heretofore commonly made of copper or brass, and supplied by tubular metal manufacturers. With restrictions on the metals, the trade has been much concerned about the supply.

The new "L" provides strength with lightness; it does not break, crack, or dent in the usual packing and handling with tools. It is stated to be leak-proof, impervious to water or to iron, lime, sulfur, salt, or other water-carried material, and to be non-corrosive. It is made of a porcelain-like, white, odorless plastic with a smooth finish inside and out. There is no enamel, paint, or plating to chip, crack, peel off, or tarnish.

CAN AN INVENTOR MAKE MONEY TODAY?

IN 1941 alone over 4,000 Assignments of Patents a month were made by inventors to manufacturers or individuals. This shows today's demand for new patented inventions. If you have ideas, write for our FREE BOOK, "Protect, Finance and Sell Your Invention" that gives you the complete facts. Special form "Invention Record" also mailed FREE. No Obligation.

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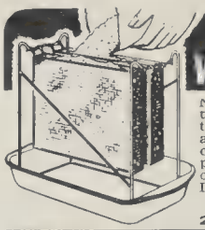

END DAMP AIR WITH "DRI-AIR"

New DRI-AIR Powder draws moisture from air in dark rooms. Protects photo equipment and supplies against dampness. Set consists of 1 complete metal unit and 10 lbs. of powder. If dealer can't supply—order direct, $3.70 plus ship. chg. DEALERS WRITE TODAY!

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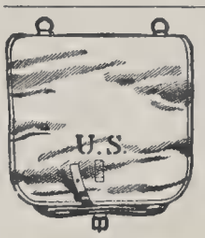

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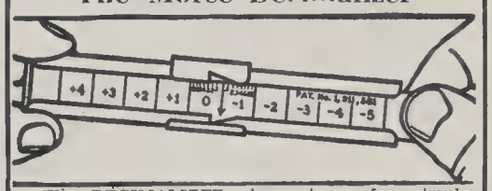

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Oxygen Saturation of an Aviator's Blood, Which Determines His Efficiency, is Quickly Measured

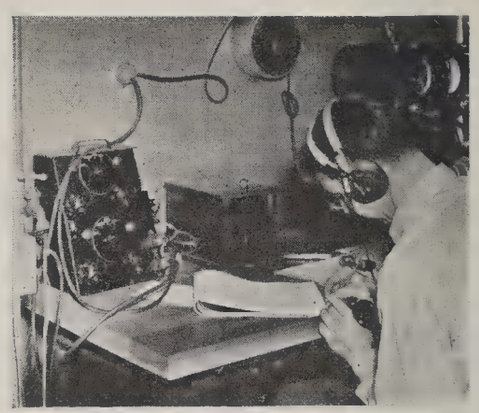
ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

A NEW device with the odd name of the "Oximeter" has greatly increased the usefulness of the altitude chamber at Wright Field, where experiments are constantly being made in regard to the effect of high altitude on the military pilot. The measure of a man's efficiency in the thin air of high altitudes is given by the oxygen saturation in his blood; if the normal reading is 95 percent at sea level, it may drop to 75 percent at 40,000 feet, even if an oxygen mask is employed, because the atmospheric pressure is so low that the subject's body cannot absorb enough oxygen to sustain life without the added protection of a pressurized suit or cabin. Exercise hastens the rate at which the oxygen content of the blood drops. At a rating of 70 percent, a man's judgement becomes unreliable, dizziness and mental confusion set in at 60 percent, and complete loss of consciousness results at 50 percent.

A soldier inside the altitude chamber with Oximeter attached to ear

Previously existing methods of determining the blood oxygen content have been slow and somewhat unreliable, but the Oximeter, designed by Dr. Glenn A. Millikan, allows rapid determinations to be made by a medical man seated comfortably outside the altitude chamber within which tests are being made. The key to an understanding of the Oximeter is a U-shaped ear-unit, with a tiny exciter lamp on one side and a light-sensitive photocell on the other. This unit clamps on the lobe of the subject's ear, so that light from the lamp shines through the lobe into the photocell. We quote Dr. Millikan: "The Oximeter capitalizes on the fact that blood changes color as its oxygen contact changes—normally saturated it is bright red, but as more and more oxygen is lost it shades off to deep purple. Purple passes less light than red, so any change in the oxygen content of the blood alters the intensity of the light which shines through the ear lobe. These changes are relayed from the photocell by wires leading through a box of resistance coils to a galvanometer. There is lag of from one to five seconds between a true reading and the actual condition of the bloodstream. This is the time required for blood to circulate from the heart to the ear. Since light obviously can penetrate a thin lobe easier than a thick one, it is necessary to determine the thickness of the subject's lobe at the outset. Lobes are classified as shell, wafer, thin, medium, or thick so that the proper scale reading on the galvanometer can be chosen."



Observer records readings of Oximeter

Many successful applications of the Oximeter have been made and it has proved to be highly useful in aeromedical research.

CARGO PLANE

For the Army, Made of Plywood

IT is no secret that one of the problems of the United Nations is transportation, that transportation by surface

Artist's conception of the new cargo-carrying plane, Curtiss C-76

vessel is slow, that air transport is a tremendous help in carrying supplies and equipment and is likely to grow in importance as the war goes on. The United States Army Air Forces are fully cognizant of the situation and are ordering large numbers of cargo-carrying planes. What is more, these new cargo planes will be built of wood and other non-strategic materials not on the Government priority lists. Again, so as not to overburden the resources of the aircraft plants building combat machines, a majority of the parts of the Curtiss C-76 (as an important new military cargo ship is called) will be built in small assemblies by manufacturing organizations which are experienced in plywood construction.

The site for construction of the C-76 will be somewhere in the East, and many men with woodworking skill are being gathered for the new plant—whose exact location must, of course, remain a secret. Secrecy also must shroud the design of the plane itself, which is shown roughly in the artist's sketch. All that the sketch reveals is a clean, twin-engine plane of about the size of the twin-engine transports operating on our airlines. Whatever the design, the effort is commendable.—*A.K.*

RESEARCH

A Few of the Many Aerodynamical Problems

THE Annual Report of the National Advisory Committee for Aeronautics, which is transmitted by the President to Congress, gives, as usual, a comprehensive review of the research problems which are attracting attention of American scientists—even though the actual results of such investigations remain shrouded in secrecy.

The introduction to the report indicates in interesting fashion the desirable lines of aeronautical development. Thus, the outstanding fighters of 1940-1941—the British *Spitfire* and *Hurricane* planes, and the German Messerschmidt 109 F—had maximum speeds of the order of 360 miles per hour. The American aircraft program must provide new fighters of much higher speed; well over 400 miles an hour. To do this, it is hardly sufficient to increase the horsepower and clean up the airplane aerodynamically. It is necessary to develop entirely new wing sections of the low-drag, laminar flow type, and it is essential to re-examine the methods of cowling and cooling. Special cowlings are needed to handle the air needed to cool the engine, the oil radiator, and the intercooler which cools the air after it has left the supercharger and before it reaches the engine.

Propellers of usual design are inefficient at very high speeds, so that new propeller blade sections have to be developed. At high speeds, the airplane is subject to "compressibility" or shock wave effects, and wings, fuselage, and other parts must be designed to eliminate "compressibility" effects as much as possible.

These are but a few of the problems considered by the Committee whose laboratories must also work on the engine, aircraft structure, and innumerable other questions.—*A.K.*

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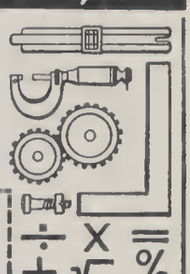

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Record or Interpret

THE line distinguishing the record picture from the so-called pictorial, or interpretive shot, is sometimes so very thin that none can blame judges when they fall to squabbling among themselves as to whether a particular print should be accepted or discarded on this ground. The pictures of iris here reproduced are a case in point.

To our mind, "Record," despite some evidences of attempts to pictorialize the

"Record"

subject, is still a record. The requirements of flower photography, that the subject should be given form and texture and that proper lighting, development, and printing should bring out both highlight and shadow detail, are fairly well fulfilled. Two Photofloods in reflectors were used for illumination, one overhead, the other roughly frontal and at some distance from the subject to fill in the shadows without destroying balance and highlight detail. Development of the Eastman Super Panchro Press negative was in a much used D-76 solution.

"Pictorial," on the other hand, hits nearer the mark as an example of interpretation. Less light and a somewhat low key effect give the desired result; to balance the gracefully tapering buds with the open flower. One Photoflood, above and a little to one side, outlines the buds and the stems but illuminates the flower sufficiently to provide satisfactory over-all lighting.

The pictures were made indoors, using a small graduate as a support, with a medium gray cardboard to serve for the background.

"Pictorial"

Sunlight After Rain

THE amateur with foresight knows that there's always the chance of the silver lining after the darkness of the storm. He knows that rain does not last forever and that when the sun shines afterward, there are pictures a-plenty. Looking forward to just such an eventuality we took the camera along one rainy day and were rewarded with the chance to shoot "Sunlight After Rain." To make the most of the mud puddles, we held the camera low, taking advantage of the sunny gleam on the roof under the tree to record the cheery effect of sunlight after rain.

"Sunlight After Rain"

M-Q Versus Pyro

WHICH is better, the modern metol-hydroquinone developers or the venerable pyro formulas? The Agfa Ansco Research Laboratories recently made some tests to find out. Two M-Q developers, Agfa Ansco Nos. 17 and 47, and the three-solution pyro formula, Agfa

Ansco No. 45, were used. A straight test showed the following: pyro developed films had better tone separation in the shadows, steeper gradation of the middle tones, and less brilliant highlights, but there was some loss of speed in the threshold region despite which, however, the negative gradation was excellent for portraiture.

Another test was made with a subject having the wide brightness scale, measured from the subject, of more than 100. One set of negatives was developed in the pyro developer, with conventional proportions, another in the same developer but with the carbonate cut to 15 drops per liter of mixed developer. Equal contrast for both sets of negatives necessitated 2 3/4 hours developing time for the modified pyro bath. All negatives were printed on Convira No. O paper, those developed in the weakly alkaline solution giving better print shadow detail and more brilliant highlights, though at the cost of heavy pyro stain and a loss of film speed equivalent to between one and two lens stops.

Pictures in Shade

ONE of the most frequent complaints we hear from beginners is that the negatives they exposed in the shade or on cloudy days when the lighting lacked contrast, were woefully flat. A simple case of cause and effect: flat lighting, flat picture. But there is a remedy. Develop such negatives a bit longer than you do those exposed under normal lighting conditions. Length of development determines extent of contrast, remember.

Imagination in Portraiture

THIS is going to be an indoor summer, someone recently said, in view of the growing restrictions on outdoor photographers. That means more portraits than we ever did before. But let's use our imagination a little and get away from the beaten paths whenever we can. Not all subjects will lend themselves to such treatments as that used here; many an effective portrait has been achieved with more or less conventional poses, the subject itself frequently being striking enough without the employment of tricks and devices. But sometimes it's good to let yourself go, even though it may look a little crazy.

"The Duke di Verdura"

In the portrait of "The Duke di Verdura," by George Platt Lynes, fashion and portrait photograper of New York City, the latter wanted to get something different when he invited his friend in for a sitting. Animation in a still is difficult, but that was the photographer's objective. He achieved it by a very simple arrangement. The subject, astride a bent sheet of linoleum and with a strong light behind, raised his hands as if balancing himself. The resulting shot, informal, gay and completely natural, pleased all.

Perspective on the Beach

SOMETHING a little different in the way of beach pictures is this purely candid shot of two bathers in lively conversation.

A good story

By moving fairly close to the figure in the foreground and angling the camera to enclose the laughing face in the triangle formed by the extended arm and inclined head of the girl in front, a feeling of nice perspective is achieved. Stopping down to *f*/16 gave sharpness.

Rainbows Grounded

RAINBOWS do not all exist in the sky. Under suitable circumstances, they descend to earth as well. Once we witnessed the phenomenon when a garage employe was spraying an automobile in the course of giving it a thorough washing. Another time we saw the same thing happen in a public park when the bright sun, as in the other instance, hit the fine drops gushing forth from a revolving garden sprayer at just the right angle, from the onlooker's point of view, to exhibit a beautiful rainbow curved in a quarter circle. Thus, the humble mortal had a close-up view of what happens in the sky: the colors of the spectrum, in the shape of a bow or arc, are formed opposite the sun by refraction and reflection of the sun's rays in drops of rain. Similar phenomena occur in spray and mist, we see. As in the sky, the grounded rainbows can be recorded in color on color film in a camera. Even pictures made in black and white will give at least a rough approximation.

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LAST month in this department, R. M. Watrous, M.D., Highland Park, Ill., described a spectroscope of the concave grating, Rowland type, which he made as a follower of the amateur optical hobby, and now, in Figure 1, is a series of spectrograms which give a better idea of the refined capabilities of such an instrument than the ones he had available at that time. The spectrogram is enlarged four times from a portion of film on which are registered ultra-violet spectra extending over that part of the ultra-violet from wavelength 3100 angstroms down to 2500 angstroms. The light which made these lines is completely invisible to the eye.

The top spectrogram was made with light from an arc between ordinary cored carbons such as are used for some kinds of lantern slide projectors. Those below it were obtained by melting bits of common metals (tin can strip, tinfoil, solder, galvanized iron, brass, copper, sterling silver, silver solder, aluminum, iron) in the heat of the arc, thus causing them to vaporize and emit their characteristic wavelengths. Some of these metals did not remain in the arc long enough to record their spectra.

Since the carbons used were not of the high degree of purity required for spectrographic analysis, the lines of the elements in the core (silicon, bismuth, and magnesium) appear in all of the spectra, and are indicated at the top by their chemical symbols. The other numbers written across the top refer to the wavelengths in angstroms.

IN THE concave grating type of spectroscope mentioned above and described last month, the slit, the grating, and the spectrum, all three, lie on the circumference of a circle whose diameter is equal to the radius of curvature of the grating. How a really large—gigantic, in fact—instrument of this type shapes up is shown in Figures 2 and 3. This is the world's second largest spectrograph, 30 feet in diameter, and is at the University of Chicago. It took over a year to build, and in size it is rivaled only by a similar spectrograph at the Massachusetts Institute of Technology. The diffraction grating, in addition to focusing the light, breaks it up into its component wavelengths and fans it out over the 40′ of photographic plate.

The physics department at the University of Chicago began making diffraction gratings under the supervision of the late Dr. Albert Michelson, and after Dr. Michelson's death, in 1931, the work was continued under Dr. Henry Gordon Gale. From five to ten of these gratings have been made every year by the University and sold to scientific laboratories in all parts of the world. Only at the Johns Hopkins University are gratings made which compare, in their power to separate the spectrum lines, with those made at the University of Chicago. The grating consists of an octagonal piece of speculum metal on which vertical lines have been ruled by a ruling engine, the time required being approximately two weeks.

The giant spectrograph fills a room 40′ square. A light beam from the compound to be studied originates in apparatus outside the room, passes through a narrow slit at the point in the photograph (Figure 3) to which Professor Robert S. Mulliken is pointing, travels across the r strikes the grating at which Miss Hamilton, a graduate student in phy gazes (this grating is shown in Fi 2), and then is reflected to diffe parts of the big circle as a large fa light. This light impinges on the ph graphic plates in a strip 2″ in width 40′ in length, arranged in a large s circle 30′ in diameter. (The inner c in the right half of Figure 3 is the tige of an older and smaller spectros of the same type.) The photogra plate is composed of 26 sections, 18″ in length. The sections are rem separately for developing in the ne

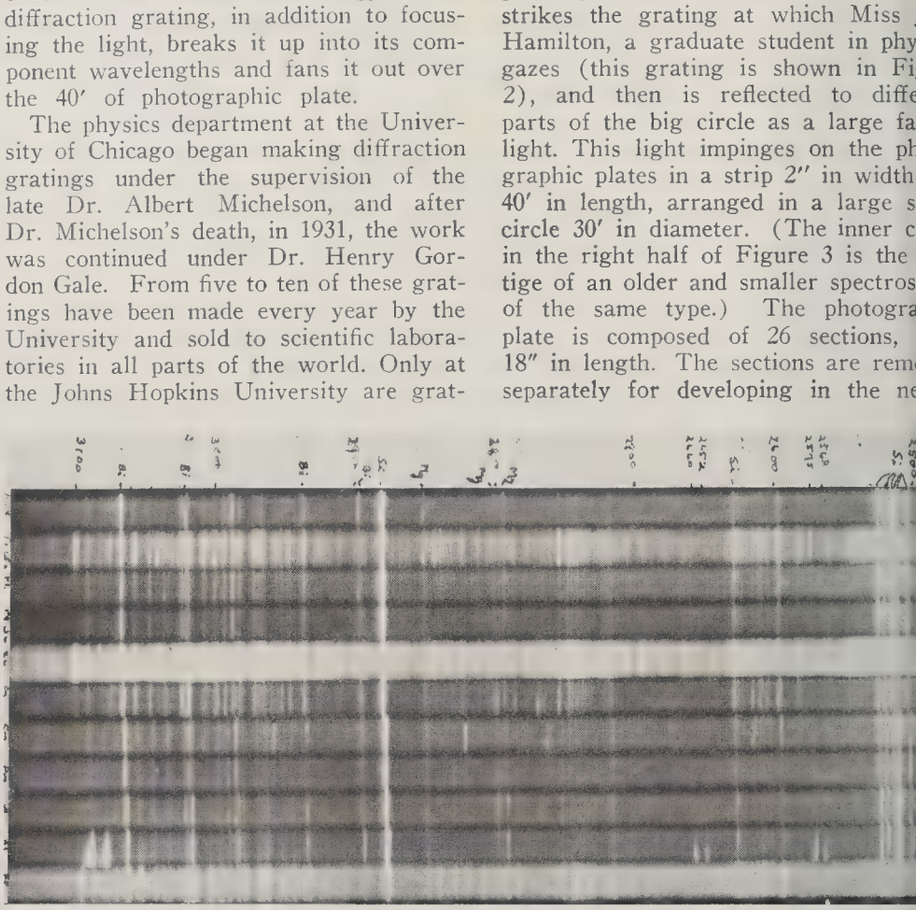


Figure 1: Spectrograms made with an inexpensive home-made spectroscope

boring darkroom. It takes from thre 40 hours to secure an adequate expo because the dispersion of the light g ly diminishes its intensity.

If an observer stands within the of light coming from the grating, walks to different parts of the roon can witness the differences in w lengths of the light in various part the fan. At one side of the room wavelengths will cause the gratin appear a brilliant scarlet. As the ob ver moves across the room the colo the grating passes from red through

Photos Chicago Times

Figure 2: Grating part of the big spectroscope

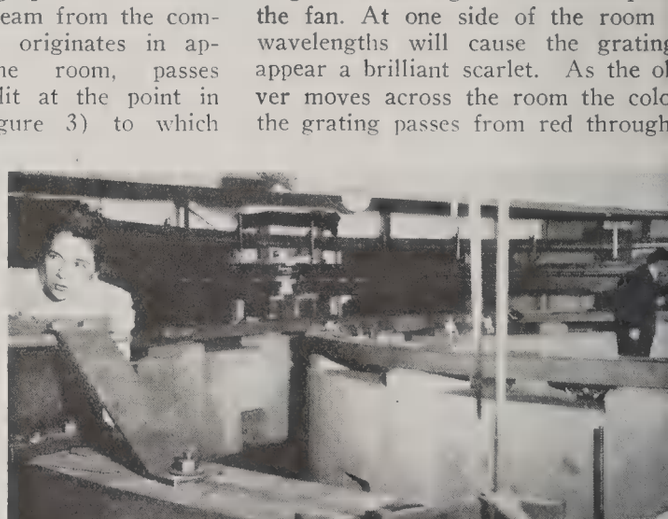
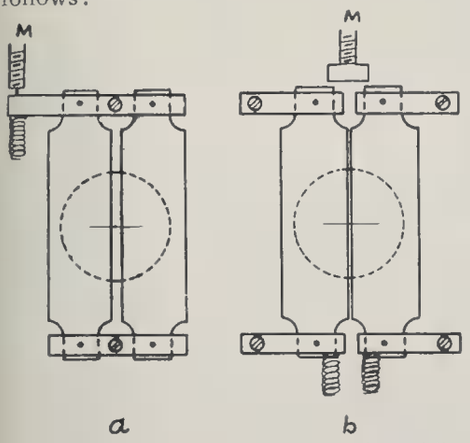


Figure 3: Slit part (shown at extreme right)

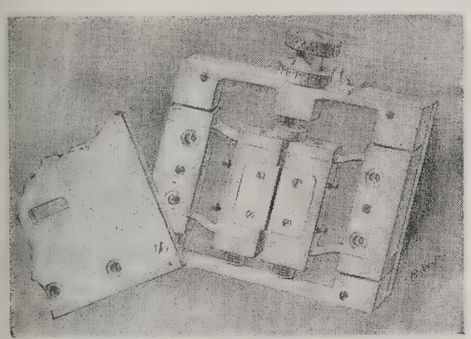
seven colors of the spectrum to violet.

SLIT for spectroscopes or other optical instruments was described by Dr. John Strong, of the Astrophysical Observatory, California Institute of Technology, in *The Review of Scientific Instruments,* Vol. 12, pages 213-214, as follows:



Courtesy "The Review of Scientific Instruments"
Figure 4: Non-uniform-speed slit

"Many types of slits have been used for optical instruments. (See H. Kayser, *Handbuch der Spektroscopie,* Vol. 1, p. 532). Among them one bilateral slit which we may term the parallelogram slit, and which is diagrammatically illustrated, in Figure 4(a), has several noteworthy features. When it is skilfully constructed, this slit is both simple and effective. The opening of the parallelogram slit exhibits an adverse non-uniform relationship to the amount of turn of the adjusting screw: The slit opening changes most rapidly when the slit is nearly closed whereas we would prefer, to have a more delicate control, that the slit opening change slowly when



Courtesy "The Review of Scientific Instruments"
Figure 5: Same slit in perspective

the slit is nearly closed and rapidly when it is nearly open. Figure 4(b) represents diagrammatically the principle of the parallelogram slit adapted to achieve this desired end and Figure 5 illustrates how we apply this principle in practice.

"Figure 5 is a sketch by Mr. R. W. Porter drawn from one of the slits of a new spectrometer under construction here. The cover plate, with the slot for illuminating the slit, is shown turned to one side. This plate is secured by screws in the four corners while the slit, as a whole, is fastened to the spectrometer by four other screws, two on the right side and two on the left.

"The micrometer screw displaces the slit jaw assemblies equally in a direction

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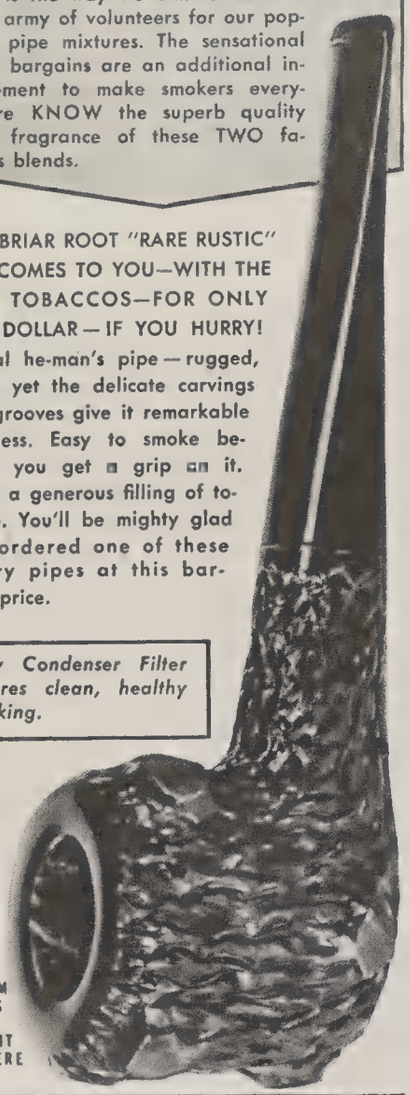

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TELESCOPTICS

parallel to the slit and, by virtue of their 0.006″ clock spring mountings, this displacement causes the slit jaw assemblies to separate and the slit to open. Two helical springs locate the jaw assemblies definitely against the hardened end of the micrometer screw. The carefully worked slit jaws are adjustably fastened to the jaw assemblies so that the jaws will close exactly.

"The advantages of this type of slit over other types are: that the jaws cannot possibly be jammed; that the slit opening is delicately controllable when the slit is narrow; and the spring mounting, as contrasted with mounting in ways, provides a definitely reproducible mechanical system. Disadvantages are: the non-uniform relation between micrometer screw setting and slit opening and certain limitations on compactness of construction. The slit is relatively easy to construct in such a manner as to yield high accuracy.

"The slit opening is given, approximately, by the expression:

$$S=2L\ [1-\cos\ (M/L)],$$

where L is the free length of the clock springs and M is the displacement of the micrometer screw from the closed position. For the slits already constructed $L=1$ cm and $M=3$ mm giving S approximately 1 mm. The slit jaws are 24 mm long while the useful length of slit is 12 mm. The over-all dimensions of the slit exclusive of the micrometer head are 3½″x3″x¾″."

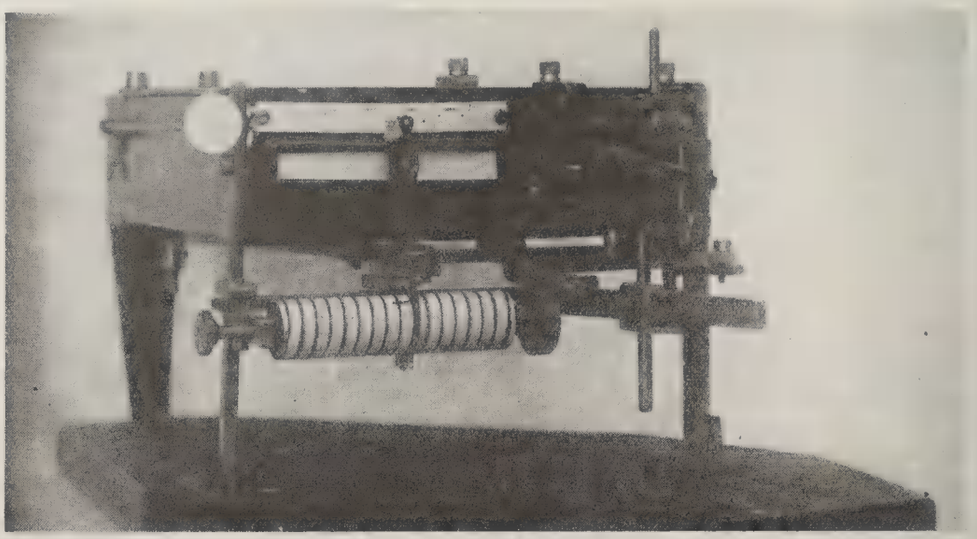

Figure 6: Smith's home-made spectroscope with calibrated drum

ANOTHER spectroscope—in fact, a spectrometer—made by an amateur is shown in Figure 6. F. P. Smith, Box 364, Ventura, California; is the maker, and he says he has followed spectroscopy as a hobby for 16 years and found it to have unlimited fascination and possibilities. "The concave grating type is the easiest," he writes, "also the most practicable to build. Gratings in the original can be obtained with a 2″ ruling and 25,000 lines per inch at $50 to $150. About $75 will build an instrument having excellent dispersion. A very good slit can be made without machine tools, the practice it gives in filing also being of value.

"In the photograph (Figure 6), the screw which is used to oscillate the grating is shown to the extreme left. The cylinder, or drum, is grooved and the groove moves the eyepiece across the spectrum as the handscrew is turned. The spiral strip on the drum is calibrated in angstrom units; it also carries the symbols of the principal lines of the elements. Thus, if 15 or 20 elements are present, the user gets a line on the crosshair and then refers to the drum.

"The camera part is at the extreme right. The round white spot is the handscrew which is used to oscillate the grating."

Smith's description was shown to Watrous, who replied: "This apparatus is undoubtedly more accurate than mine, though probably more difficult to build. The more expensive gratings must give much better definition."

CONTACT: "I have long ago abandoned the pencil mark system for measuring contact between mirror and tool," Cyril G. Wates of Edmonton, Alberta, Canada, writes, "not because of the alleged danger of scratches, but because it doesn't work—at least, not for me. So I took a leaf from the mechanic's book—he uses Prussian blue in making face plates—and put a streak of dry rouge on the tool, and judged contact not by rubbing out of the streak, but by the rouge which was transferred to the mirror. This, as I mentioned in 'A.T.M.A.,' works well, but I have found, especially with Pyrex, that the faint rouge marks are difficult to distinguish.

"Recently I discovered a very satisfactory substitute in artist's Black Stumping Chalk. This is a very fine black powder—probably pure carbon—and a little may be taken on the finger tip and rubbed across a diameter of the tool. After dusting off the loose particles, one mirror is pressed into contact and rubbed gently, without pressure. When the mirror is removed, the points of contact will show on the face of the mirror like an Ethiopian on a snowbank."

NO STELLAFANE convention this year. War. Everybody busy, and local hosts busy too. Town crowded. Also tires, gas. Better to wait for the dawn of peace.

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DOMESTIC RUBBER 'PLANTATIONS' . . . Page 105

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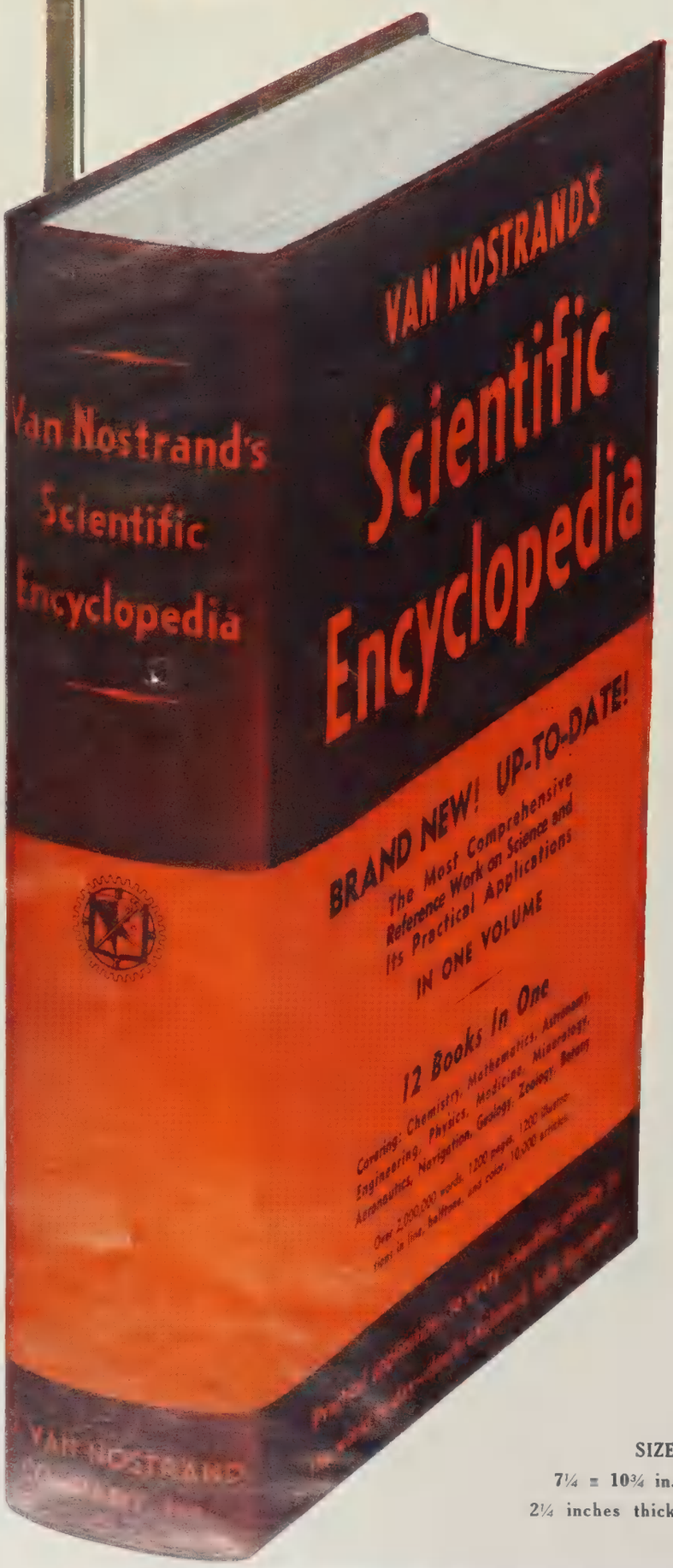
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VIRTUALLY completed is the great mounting for the 200-inch telescope in California—our cover picture this month—but at least a year's work remains to be done to complete the mirror. However, both are now "put away in mothballs"—work entirely suspended—for the duration. The photograph is by George Herbig of the Griffith Observatory in Los Angeles. See also page 142.

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OUR *Point* OF VIEW

A FLASH OF GENIUS

STRANGE things often happen in court, but seldom if ever has a stranger theme been dwelt upon than that which the Supreme Court of the United States brought forth in a recent decision in a patent case. Neither the facts of the case nor the merits of either side are of any moment here, so they can be passed by. The meat of the decision, as far as the possible future of patent law is concerned, is contained in the statement by the court that the test of patent validity is whether or not the alleged invention reveals a "flash of creative genius."

A "flash of creative genius"! Upon such a basis practically every patent ever issued in the United States or elsewhere would be invalid. Classic is the tale of Edison's long and heart-breaking search for a material from which to make incandescent lamp filaments. No flash of genius there. Bell labored long and often despairingly before wires carried speech. Again no flash. Marconi created many failures before he ultimately achieved success. No flash in that. And the list could go on and on, proving that inventive genius is not given to flashes, that the patents upon which are based our great industrial world of today have been the result of much perspiration and mental anguish, seldom if ever lightened by a helpful flash.

Now that we are at war, things of this sort go on every day, often passing un-noticed. The pressure of war, total war, frequently warps perspective to a point where it is unappreciative of the damage that can be done by a matter that seems unimportant in the face of world-shaking events. But there is a time of peace coming, a time when attention will be turned from the nerve-rending pressure of war production to the pursuits of peace. Then, when our industrial machine again shifts gears, will come the realization that new ideas, reduced to practice and protected by patents, are the basis of our industrial structure. If the test of a "flash of creative genius" is going to be applied to such patents, this nation is going to find itself in a horrible period of industrial stagnation. This must not be allowed to happen. When the period of reconstruction comes, the aid of the inventor will be needed more than it was ever needed in all the past years of technological development. Upon inventions and patents will be built the new industries needed to carry on the traditions that are so much a part of the American way. Let's forget about such manifestly foolish things as these "flashes" and concentrate on methods of encouraging the inventor by guaranteeing to him, even more than ever before, the fruits of his hard labor.—*O.D.M.*

SHARE THE "KNOW-HOW"

SINCE 1845 the pages of this magazine have been largely devoted to the dissemination of information regarding new industrial processes, new ways of doing things easier, faster, more economically, new methods of attaining new ends—in short, to spreading the "know-how."

At no time in the history of this country has there been more reason, more need, for this sharing of knowledge than there is at the present moment. Many of the larger industrial organizations are realizing this fact and are doing everything possible to spread to others, even to active competitors, news of their newest developments in many lines. Reason behind all this, of course, is the war effort. Everything possible must be done to increase production of the things needed to insure victory, and only by a vast pooling of information can this end be achieved in the quickest, most economical manner.

Outstanding proponent of the need for sharing the know-how is Westinghouse. By every available means that organization is spreading to the industries of the nation the story of what they are doing and, where it can be told without revealing military secrets, how they are doing it. Much of this story has appeared in the pages of Scientific American, and that it has been welcomed by many readers is evidenced by our correspondence.

We have mentioned only one example; there are dozens of others, but still not too many, still not even enough. The job that is being done in some small plant that no one ever hears of outside the four walls of the shop may be just as interesting, just as informative, just as important to other industries as it is to that small plant. And, too, it may have an equally large bearing on the success of the war effort.

With all this in mind, the editors of Scientific American will welcome contributions from responsible members of industrial organizations, telling of some new method of operation, some new material that has been developed for a specific purpose but which may be adaptable to other uses, some new operation performed with an old tool—anything, in fact, that will contribute materially to sharing the know-how. We cannot, of course, promise to publish all contributions. Each one, however, will be carefully considered and its value to the greatest number of readers will be accurately weighed in the editorial balance.

The door is open, the welcome mat is out. Here is your chance to share your know-how for the greatest good of the greatest number.—*A.P.P.*

LIGHTER THAN AIR

ALTHOUGH not much information about their operations appears in the press, it is an open secret that blimps are playing a large and important part in the "Battle of the Western Atlantic." While, at the time of writing, we are still losing many surface vessels to the predatory packs of submarines that infest our eastern coast, the so-far unwritten record of achievement of these versatile lighter-than-air craft is apparently an inspiring one. Where the blimp holds the advantage over the patrol plane is in its slow speed that permits more careful inspection of the water below and its ability to hover over one spot for almost any desired length of time.

Perhaps the good work of the blimps influenced to some extent the recent action of Congress in authorizing an increased appropriation for lighter-than-air craft. In any event, we are going to hear a lot more about this type of aerial transportation in the near future.—*A.D.R., IV*

50 Years Ago in . . .

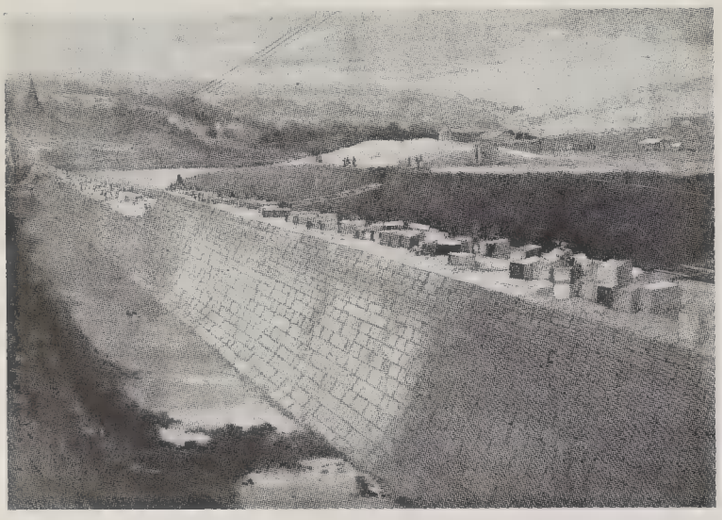
SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1892)

RUBBER—"Copper salts have an injurious effect upon India rubber. . . . Metallic copper in contact with rubber causes oxidation and hardening of the gum, although no appreciable amount of the metal enters into it. Zinc does not in any way affect the rubber. Oil containing even small amounts of copper coming in contact with rubber goods is highly injurious. . . . All oils, except castor oil, exert a detrimental effect upon rubber."

TRIPLE SCREWS—"The fastest of the vessels of our new navy, the Columbia, will have a speed of 21 knots, with a possibility of doing 22 knots. She will, to do this, have greater horse power than any vessel ever before built in America, and is, with one exception, the first large vessel ever built with triple screws."

AUSTIN DAM—"There is being built across the Colorado River at Austin, Texas, a massive granite dam, the object of which is to furnish the city with water works and electric light, and to also furnish manufacturing enterprises with cheap water power. This wonderful structure is 1,200 feet in length, and 60



feet high. It is 16 feet thick at the top, increasing downward and spreading out in a broad toe or apron, making its extreme width at the bottom 50 feet. . . . The water will be drawn from the penstocks through iron pipes, pass the wheels, fall into the wheel pits, and be discharged through underground races into the river. There will be three water wheels, forty-five inches in diameter, each capable of giving 600 horse power on a head of 60 feet. . . . During the flood season the amount of water that will flow over this dam, it is estimated, will be 200,000 to 250,000 cubic feet per second, which is nearly equal to the volume at Niagara Falls."

INVENTION—"No argument is needed to show that to invention must be accorded a very high place among instrumentalities for promoting progress, but some believe that no new principles remain to be discovered, and that there is little if any unknown material; therefore, they say, great inventions in the future must necessarily be few. Such is the argument of the pessimist, which at first may seem rational, but seen in the light of modern progress must give way to the opposite view, which holds that every new discovery or invention is almost sure to lead to other discoveries and inventions of equal or greater importance; that we are only on the borders of the realm of invention, and that the possibilities of the future are far greater than those of the past. This is the optimist's view, which is backed by history, reason, and common sense."

PHOTOGRAPHERS—"Professional photography at the present time is admittedly not in a flourishing condition, and the causes commonly assigned for the depression include, of course, bad trade, severe competition, and the influence of the once despised but now potent amateur."

WOODEN—"The sailing ship Roanoke, launched at Bath, Me., lately, is said to be the largest wooden ship afloat. Her length is 311.2 ft.; breadth, 49.2 ft.; depth, 29.2 ft.; gross tonnage 3,539."

VOLCANOES—"Tropical America presents some of the most superb volcanic spectacles in the world. In Ecuador are twenty volcanoes from 16,000 to 22,500 feet high, eighteen of them being crowned with eternal snow, and eleven never having been scaled by any living creature. Fifty more exist in the Central American region, and twenty-one in Mexico, chief of which is the lordly Popocatapetl."

SPARK PHOTOGRAPHY—"Professor Vernon Boys lately explained that by the electric spark articles moving at the rate of 10,000 miles an hour can be photographed, and by the introduction of a revolving mirror a speed of 180,000 miles an hour can be coped with. The mirror makes 1,024 turns every second, worked by electricity, which is equal to about 150 times as fast as a rifle bullet travels. The whole photographic power of the spark is over in a time equal to the ten or eleven millionth part of a second, and it is during that incredible brief space that the image is made on the sensitive plate."

RAILROADS—"According to the *Street Railway Review*, there are now nearly 1,000 street railway companies in the United States, of which fully 400 are electrically operated, in whole or in part."

PYRAMID BUILDERS—"A two years' study at Gizeh has convinced Mr. Flinders Petrie that the Egyptian stone workers of 4,000 years ago had a surprising acquaintance with what have been considered modern tools. Among the many tools used by the pyramid builders were both solid and tubular drills and straight and circular saws. The drills, like those of today, were set with jewels (probably corundum, as the diamond was very scarce), and even lathe tools had such cutting edges. Of the . . . method of making the tools nothing is known."

TELEPHONE—"In speaking of the future of the telephone, Professor A. Graham Bell says: 'The telephone, as at present constructed, needs the open air to obtain the best results. To use wires placed underground, a metallic circuit will be necessary, similar to the one used now on long distance lines. To place the wires under ground and to make a metallic circuit, which means to use two wires where one is used at present, will materially increase the expenses of the company, and the public must pay for the luxury. As the number of wires is increasing rapidly, it is evident that they must ere long be buried.'"

Clear the Lines for the War

Before you make a Long Distance telephone call today, ask yourself these questions:

1. Is it necessary?
2. Will it interfere with war calls?

The weight of war on the telephone lines is heavier every day. We can't build the new lines to carry it because sufficient materials aren't available. We've got to make the most of the service we now have.

Please give a clear track to the war effort by confining your Long Distance calls to those that are really necessary.

WAR CALLS COME FIRST

BELL TELEPHONE SYSTEM

98TH YEAR SCIENTIFIC AMERICAN SEPTEMBER 1942

NAVAL INDISPENSABLES

Cruisers Can Perform a Wide Range of Missions

WALTON L. ROBINSON

● Third article of a series on the ships of the United States Navy. The next, dealing with destroyers, is scheduled for October publication. Former articles were on battleships and carriers and were published in May and August.—*The Editor.* ●

ASIDE from battleships and aircraft carriers, cruisers are the largest, costliest, and most formidable type of naval vessel. But unlike carriers, which are not, strictly speaking, combatant units, cruisers are fighting ships in every respect. Well armed and fast, they can perform a wide variety of missions. Their presence with the battle fleet in a major action is essential for scouting duties, for supporting destroyer attacks on the enemy, and for repelling hostile ones. Cruisers are also indispensable components of the carrier striking groups which have become such an important and spectacular feature of the aero-naval warfare in the Pacific, while on detached service they can operate very effectively as commerce raiders or as escorts to valuable merchant ship convoys. Most modern cruisers displace from 5000 to 10,000 tons, are armed with six to fifteen 6-inch guns or six to ten 8-inch weapons, and have a speed of 32 to 35 knots. Some of them, particularly those designed for very high speeds have less armor protection than battleships, but the majority do have armored water-line belts, armored decks, and plating on the gun-houses.

The United States Navy is very well provided with cruisers. At the time of the Japanese attack on Pearl Harbor we had in service 18 "heavy" cruisers armed with 8-inch guns and 19 "light" cruisers mounting 6-inch weapons. Six additional light cruisers, four of them of an entirely new design and carrying 5-inch guns, had been launched and were rapidly nearing completion. One of the 5-inch gunned ships, the 6000-ton *Atlanta,* was commissioned before the end of the year. Fifty other cruisers, including six huge units of some 25,000 tons each, were under construction or on order.

Our 37 heavy and light cruisers ready for sea on the outbreak of war had an aggregate displacement of 329,550 tons and mounted a total of one hundred and eighty-four 8-inch and two hundred and forty-five 6-inch guns, giving us a cruiser force second only to Britain's in all-'round fighting strength. Japan, with at least 40 modern cruisers, enjoyed a slight numerical superiority over us, but the Nipponese ships were generally smaller and less powerfully armed than ours. They displaced some 285,000 tons and carried one hundred and four 8-inch, one hundred and forty-four 6.1-inch, and one hundred and twelve 5.5-inch guns.

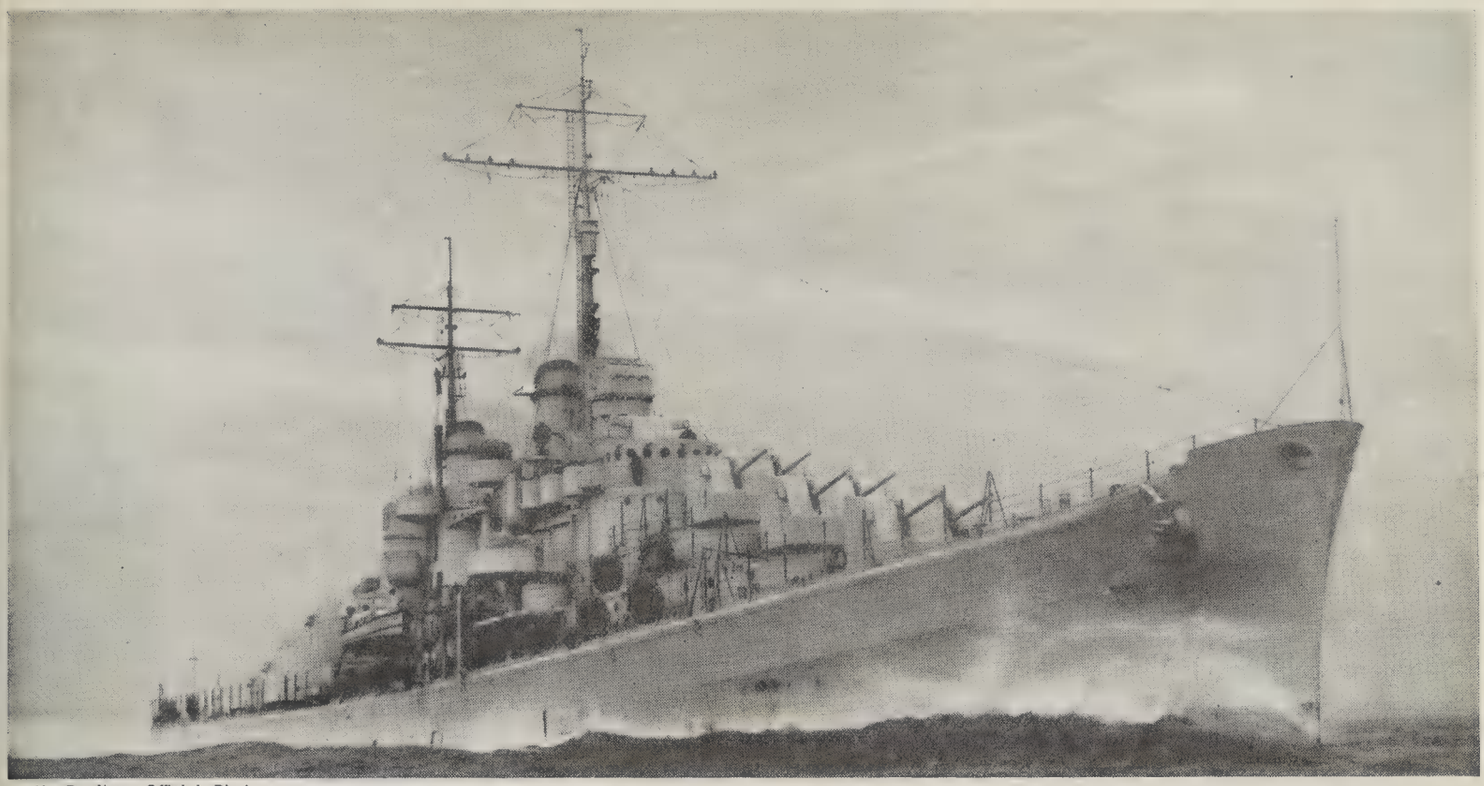
America's oldest cruisers are the ten still very servicable units of the 7050-ton *Omaha* class. They were ordered in 1916-19 and the *Omaha* and *Milwaukee,* laid down in December, 1918, entered service in 1923. The remaining ships, begun in 1920, were completed in 1923-25, the *Memphis,* last of the class, being commissioned February, 1925. All of them originally had a main armament of twelve 6-inch, 53-caliber guns firing a 105-pound shell at a maximum range of some 22,000 yards, or about 13 miles. In recent years, however, two 6-inch guns were removed from the *Cincinnati, Detroit, Marblehead, Raleigh,* and *Richmond,* and these ships now carry only ten guns. The *Concord, Memphis, Milwaukee, Omaha,* and *Trenton* still retain their original armament.

Until recently the anti-aircraft battery consisted of four 3-inch guns (six in the *Concord*) and eight machine guns, but this has now been considerably increased. Six torpedo tubes firing 21-inch "tin fish" complete the *Omahas'* offensive power, while several planes add immeasureably to their range of vision when engaged on scouting missions. In normal times only two aircraft are carried, but four can be accommodated when desired. Two catapults are provided for launching them into the air. Armor protection includes a 3-inch water-line belt and a 1½-inch deck over engine and boiler spaces.

Westinghouse, Curtis, or Parsons geared turbine engines driving four propellers and developing 90,000 horsepower, give the *Omahas* a designed speed of 35 knots. This speed, however, can only be maintained for brief periods and then with considerable difficulty. Oil fuel capacity is about 2000 tons, sufficient for a cruising radius of some 10,000 miles when the ships steam at their most economical speed (15 knots). At 20 knots their radius of action drops to around 7000 miles, and at 30 knots to some 3000 miles.

THE *Omahas* were our Navy's only modern cruisers throughout the 1920's or until the completion early in 1930 of the *Pensacola* and *Salt Lake City.* The construction of these two ships, together with that of six other cruisers, was authorized late in 1924. It was decided that all of them should be of the largest size (10,000 tons displacement) and mount the heaviest guns (8-inch) permitted by the Washington Naval Treaty of 1922.

The *Pensacola and Salt Lake City,* laid down in 1926 and 1927 respectively, were ready for service early in 1930 and, following their "shake down" cruises, joined the Scouting Force, U. S. Fleet. Although designed to treaty limits, their actual displacement is only 9100 tons. With their ten 8-inch guns they a.e, however among the most powerfully armed



U. S. Navy Official Photo

Cruiser *Atlanta*, believed to have extraordinary armament

cruisers in the world. These guns, 55 calibers in length, elevate to 45 degrees and hurl a 250-pound shell. They are grouped in two triple and two twin mounts, the former being in the superimposed positions. The anti-aircraft battery, which for some years consisted of four 5-inch, 25-caliber guns, was recently increased; details, however, are restricted. Six 21-inch torpedo tubes were originally carried, but were removed in order to provide space for additional anti-aircraft guns.

A 3-inch belt of armor along the water-line and two decks, 1 and 2 inches thick, protect the vital engine and boiler rooms, while 1½-inch plating is on the face of the 8-inch gun turrets. Four planes and two catapults, mounted between the funnels, give these cruisers a wide range of vision.

Designed speed of 32.7 knots is obtained by geared turbine engines developing 107,000 horsepower and driving four propellers. Steam is supplied by eight boilers with a working pressure of 300 pounds per square inch. Radius of action is some 13,000 miles at 15 knots. These engine- and boiler-room data apply generally to all of our heavy cruisers except the new *Wichita*.

FLUSH decked, the *Pensacolas* suffer from lack of freeboard (height of deck above water-line), and roll at low speeds, but are remarkably steady when steaming at 20 knots or more. The greatest economy in weights was practised in their construction, aluminum alloy internal fittings replacing steel wherever possible. Electric welding instead of riveting was also employed extensively.

The six ships of the *Northampton* class, all laid down in 1928, followed the *Pensacola* and *Salt Lake City* into service in 1930-31. Differing in minor details, their displacements ranged from 9050 to 9300 tons. One of them, the *Houston,* was flagship of Admiral Thomas C. Hart, Commander in Chief, Asiatic Fleet, on the outbreak of war and was sunk by the Japanese during the night of February 28-March 1 in Sunda Strait, between the islands of Java and Sumatra. Her sister-ships are the *Northampton, Chester, Louisville, Chicago,* and *Augusta.*

These cruisers have exceptionally graceful lines and are a considerable improvement over the *Pensacolas,* from which they differ markedly in distribution of armament and general design. They carry nine 8-inch guns disposed in three turrets, two forward and one aft, and originally had four 5-inch anti-aircraft guns. Torpedo tubes were removed several years ago and the additonal space thus made available was devoted to increased defense against air attack. Armor protection is much the same as in the *Pensacolas.*

Instead of a flush deck, the *Northamptons* have a raised forecastle deck, while a spacious hangar, accommodating from four to six planes, is located just forward of the second funnel. Two catapults, on high mounts, are immediately in front of the hangar. The *Chicago* and *Augusta,* specially fitted as flagships, have their forecastle extended aft to the catapults in order to secure the extra accommodation required.

In 1930 two more heavy cruisers, the 9800-ton *Portland* and 9950-ton *Indianapolis,* were laid down, having been authorized the previous year. Completed early in 1933, they are simply a development of the *Northampton* design with alterations in weight distribution to improve stability. The height of their masthead fire-control top is lower by 30 feet, but their bridges are higher and have some 40 tons of armor plating spread over them. Eight 5-inch anti-aircraft guns are carried. No torpedo tubes were included in the design. Aircraft-handling arrangements are as given for the *Northamptons.* The *Indianapolis* is fitted as a flagship and can be distinguished from the *Portland* by her longer forecastle.

IN 1930-31 the keels were laid for five new cruisers: the 9950-ton *Astoria, Minneapolis, New Orleans, San Francisco,* and 9975-ton *Tuscaloosa.* All were launched in 1933 and completed the following year. Two more units, the 9375-ton *Quincy* and 9400-ton *Vincennes,* begun in 1933-34, entered service in 1936-37. These seven ships are of an entirely new design, differing radically in appearance and defensive qualities from our older heavy cruisers. Their forecastle has been extended to the second funnel with a slight reduction in freeboard; bow form altered; light pole masts substituted for heavy tripods; bridges raised; anti-aircraft guns re-distributed; and plane catapults and hangar

moved aft, the latter extending to the shelter deck. Their armament is identical to the *Portlands'* but protection is much stronger, consisting of a 5-inch water-line belt, 3-inch and 2-inch decks, an 8-inch conning tower, 5 to 6 inches on the gunhouses, and plating on the bridges.

U. S. Navy Official Photo

The *Memphis:* She still retains her original armament

OUR latest heavy cruiser, the 9324-ton *Wichita*, laid down in October, 1935, and completed three and one-half years later, was originally to have been a unit of the *Astoria* class. As completed, however, she differs as much from the *Astorias* as these ships differ from the *Portlands*. The *Wichita* is, in reality, a heavy cruiser version of the *Brooklyn* class of light cruisers. She has a flush deck with a high freeboard and a square stern. Her armament comprises nine 8-inch guns disposed in the conventional manner and eight 5-inch aircraft weapons, two of which are mounted fore and aft in super-imposed positions above the 8-inch gun turrets. Armor protection is about the same as the *Astorias'* but plane-handling arrangements are utterly different. The hangar, which is located below decks in the extreme stern, can accommodate as many as eight aircraft.

The *Wichita* is powered by Westinghouse geared turbines developing 100,000 horsepower and driving four propellers. Her designed speed is 32.5 knots, which is slightly below that of any of our other heavy cruisers.

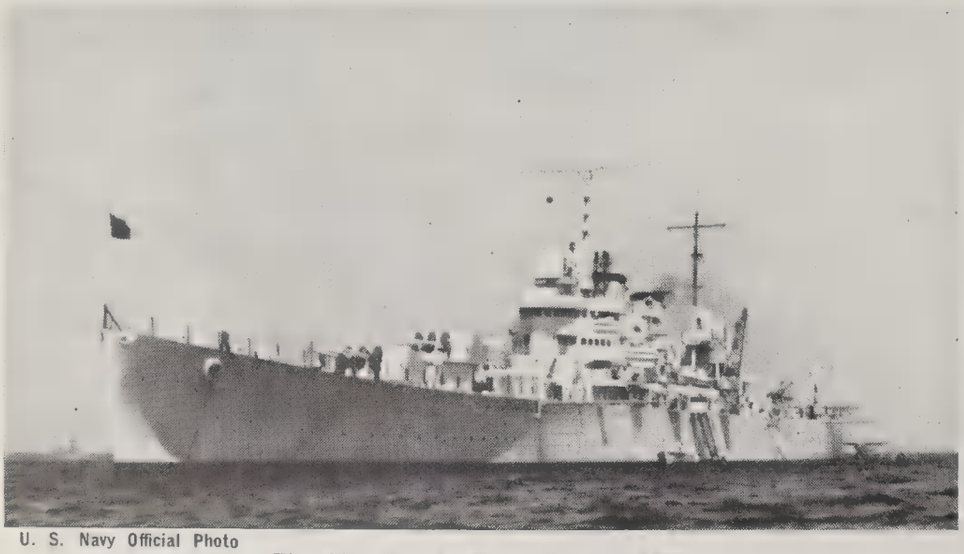
In the years 1934-39 nine large, powerfully armed, and stoutly protected light cruisers were laid down and completed for the U. S. Navy. They were a direct "reply" to the 8500-ton Japanese cruisers of the *Mogami* class, armed with fifteen 6.1-inch guns. The *Brooklyn, Philadelphia, Savannah, Nashville,* and *Honolulu* joined the fleet in 1938 and the *Phoenix, Boise, Helena,* and *St. Louis* followed in 1939. Their displacements range from the 9475 tons of the *Savannah* to the estimated 10,000 tons of the *Helena* and *St. Louis,* which are a slight modification of the earlier design. These cruisers mount fifteen 6-inch guns grouped in five well armored turrets disposed along the center-line and eight 5-inch and numerous smaller anti-aircraft weapons.

America's newest light cruisers are the 6000-ton *Atlanta, Juneau, San Diego,* and *San Juan.* Laid down in 1940 for completion in 1943, they are now entering service—a splendid example of how our shipbuilding has been stepped up. The *Atlantas,* whose design incorporates many novel features, are apparently intended to operate as leaders of destroyer flotillas and as fleet anti-aircraft escort ships. They are the fastest American cruisers ever built.

THE *Atlantas* are believed to mount an extraordinary armament: sixteen 5-inch, 38-caliber "dual purpose" guns which can be used effectively against aircraft as well as warships. These guns are believed to be disposed in eight twin turrets, three forward and three aft on the center-line and two aft on the main deck, one to port and the other to starboard. The center-line turrets are super-imposed one above the other. The anti-aircraft battery proper is believed to consist of twelve 1.1-inch pompoms in three quadruple mounts on platforms, two forward on either side of the bridge and one aft between the after fire-control tower and the topmost super-imposed 5-inch gun turret. These pompoms, together with a half-dozen heavy machine guns, will be employed against low-flying aircraft such as dive-bombers and torpedo planes. Eight 21-inch torpedo tubes in quadruple mounts complete the offensive power of these remarkable ships. On trials, speeds in excess of 40 knots have been attained.

Of our 52 cruisers under construction or on order, 32 are of the *Cleveland* class, modified *Brooklyns* with a probable armament of twelve 6-inch guns; eight of the *Baltimore* class, 13,000-ton editions of the *Wichita* design with stronger anti-aircraft batteries and greater armor protection and cruising range; six of the *Alaska* class, "mystery ships" reportedly displacing some 25,000 tons and officially designated "large cruisers"; and four additional units of the *Atlanta* class. The two remaining cruisers, authorized last December under the 5 percent increase in the two-ocean Navy, will probably belong to one of the above groups.

Many of these cruisers are scheduled for completion this year. Their entrance into service should influence greatly the course of the war at sea, for our Navy will then be able to provide stronger escorts for convoys in the North Atlantic and Pacific and strike telling blows at Japan's vital bases and extended lines of communications.



U. S. Navy Official Photo

The *Phoenix* joined the fleet in 1939

Domestic Rubber 'Plantations'

Scrap Rubber, Reclaimed, Can Go Far to Fill the Gap in Military and in Some Civilian Needs

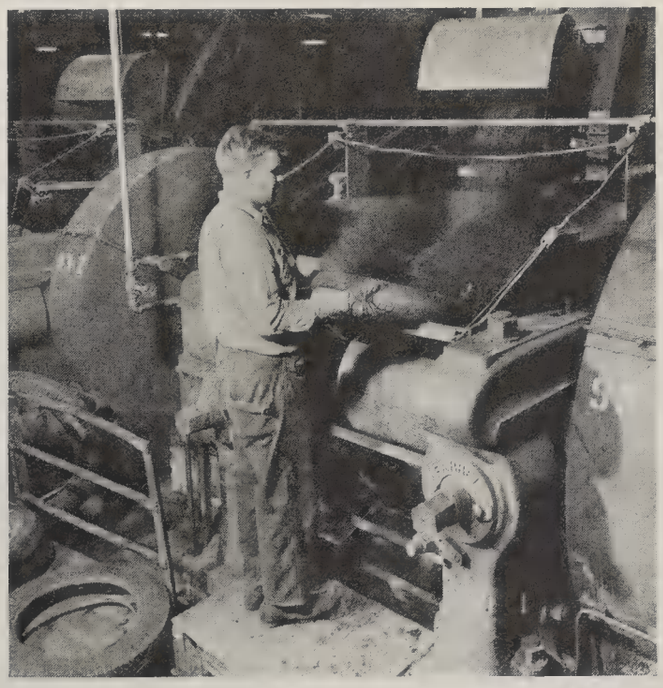
A. P. PECK

THIS business of reclaiming various types of manufactured rubber objects and putting their basic material back into the channels of trade is not so new as the recent publicity on "rubber drives" might lead one to believe. Since shortly after the very beginnings of the rubber industry, much attention has been put to reclaiming the rubber in objects which have served their original purpose. (A brief paragraph on the reclamation of rubber appeared on the "50 Years Ago" page in Scientific American in our issue of May 1942.)

During the past few months we have heard much about three different "kinds" of rubber: Natural rubber, synthetic rubber, and reclaimed rubber. That there will be little or none of the first of these available, so far as civilians are concerned, for the duration of the war is already an established fact. Commercial production of various types of synthetic rubber is already underway but on a relatively small scale; it will be at least a year if not longer before this production approaches a point where it can start to satisfy even the immediate needs of the military forces. There is little hope that any synthetic rubber will be available for civilian purposes for a considerably longer period of time.

This leaves reclamation as the one source from which civilians may hope to get at least a part of the rubber products which are essential to everyday life and, as newspaper publicity has so well told, the amount of reclaim that will be available depends largely upon Mr. and Mrs. John Citizen themselves and on the continuing response which they make in supplying the objects from which reclaim can be obtained.

Actually, the reclaimed rubber industry is by no means the ugly duckling that its name might seem to indicate. Reclaim itself, furthermore, is certainly no object of scorn, particularly in these days of economic stress. For many years it has served an honorable array of purposes in the rubber goods market, without public fuss or fanfare. The fundamental fact to keep clearly in mind is that reclaim can be used—either all by itself or in any degree of mixture with crude rubber—for the manufacture of almost anything that can be made from crude virgin rubber, but that there is always a loss in performance in the resulting process, this loss being in direct ratio to the proportion of reclaim used.



Old tires, with the wire beads removed, are ground to powder, which is then routed to the digester tanks

As in all questions, there are two sides to this one. There are some rubber products in which it is so essential to have the maximum efficiency of 100 percent virgin rubber that reclaim cannot enter the picture at all. Innertubes for vehicle tires are the best example of this. On the other hand, reclaim can be just as exclusive in its own field. Rubber heels and hard rubber products such as battery cases and combs are examples of products in which reclaim is actually superior to virgin crude because of various mechanical reasons.

A brief survey of the reclaiming process itself will aid in an understanding of the relationship between crude and reclaimed rubber.

When scrap rubber of any kind is first received at the reclaiming plant, it is assorted according to its present form and according to the process to which it will be subjected for reclamation. Since tires are uppermost in everyone's mind today, the reclamation of them in one rubber company's plant will be taken as an example.

Before the tires start in the cycle which will reclaim the rubber content, the steel wire in the beads is removed. The tire carcass is then fed into a grinding machine where rubber and cotton fibers alike are reduced to powder. After magnets remove any small particles of iron and steel, the powder is routed to digesters where it is treated with dilute caustic soda, at high temperatures and pressures, to dissolve the fibers. This treatment, by the way, has an important effect on the quality of the finished reclaim and is varied according to the material being processed.

From the digesters the material passes through a washing screen where the caustics are removed. From here it goes to the driers, where it is subjected to heat and steam pressure for eight to twelve hours before going to the mixing mill. In that mill the powder is still further ground, then washed and dried and thoroughly mixed and kneaded on steam-heated rolls.

From the mixing mill the reclaimed rubber undergoes a "straining" process where, under steam pressure, it is forced through fine screens to remove the last possible vestiges of dirt and foreign matter. From these screens the rubber emerges looking like black spaghetti.

In the final step, the black spaghetti is rolled and formed into slabs for use in the manufacture of various rubber products. These slabs are soft and plastic; the rubber, however, is not restored, either chemically or mechanically, to the full power and life of virgin rubber. It still has a certain amount of bounce and resiliency, but the exact amount depends upon the quality of the material fed in at the beginning of the reclaiming process and upon the reclaiming process itself.

The reclaim still contains most of the chemicals—sulfur, carbon black, and so on—that were put into the original object when it was manufac-

The mixing mill. Steam-heated rolls knead and mix scrap being processed

tured from crude rubber. By the same token, it has a smaller proportion of the native rubber molecules. Thus it can be seen that if the reclaiming process were repeated a number of times the undissolvable foreign elements would eventually so far outnumber the rubber elements that the result would be a conglomerate mass that would be more like asphalt than rubber.

WHILE few authoritative figures are available regarding reclaim, it appears that in October 1941—note that this was before Pearl Harbor—the rubber industry consumed about 4½ pounds of reclaimed rubber for every ten pounds of new rubber. During the first World War, statistics indicate that a proportion of about 57 percent as much reclaimed as new rubber was consumed during 1917. Again, during 1928, consumption of reclaim climbed to a high of 51 percent of the crude rubber consumed, as a result of several years of high-priced natural rubber. It also appears that 1941 was the biggest year in history for the production of reclaim, with about 280,000 long tons being turned out. The total reclaiming capacity of the nation at the present time—on a 24-hour day seven day a week basis—is about 320,000 long tons a year. This production would be possible, of course, only if the flow of scrap rubber to reclaiming plants were such as to maintain that all-out operation.

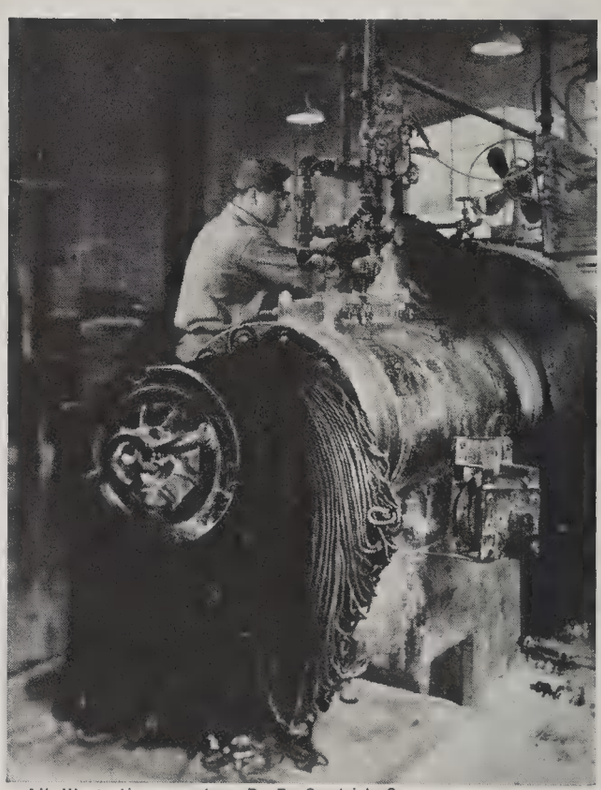
Probably what the average civilian is largely concerned with, as far as the rubber situation goes, is automobile tires. What can reclaim do to alleviate the present tire situation?

The answer at the present moment appears to be that it can't do much, if anything. In the first place, all of the rubber for tires that is obtained by reclaiming methods will undoubtedly go immediately into military, lend-lease, and other vital channels. The probabilities are that little, if any, can be spared for ordinary civilian use. Even if it could, reclaim alone is not too good for use in motor vehicle tires. True enough, there have been made for many years automobile tires in the lower price brackets which have contained sizeable amounts of reclaim. These tires have given reasonably satisfactory service but it must be remembered that they contained a relatively large percentage of crude. If, however, attempts were made—and such attempts are not even being contemplated at the moment—to make "war tires" entirely of reclaim, the use of such tires would mean re-educating the public to totally new driving habits. These tires would not give even the service of pre-war second- or third-line tires, they would have to be driven at slow speeds, and they would have to be given every consideration to prolong their inherently short service life.

Today, therefore, the most important use of reclaim, as far as tires are concerned, is in the production of wartime grades of camelback for retreading and recapping. One bright spot in the reclaim story today is the fact that present-day scrap is better than that of only a few years ago because it consists largely of rubber fortified with superior organic accelerators and with lower sulfur ratios than in earlier years. Furthermore, it is protected by anti-oxidants and the better quality of rubber products resulting from this compounding of the original crude will, of course, carry through into the product made from reclaim.

EVEN before the emergency, many articles in everyday use were (and still are) made of 100-percent reclaim. To mention just a few of them, the list would include rubber heels, floor mats, flooring, hard-rubber goods, bath sprays, jar rings, fly swatters, door wedges, weather stripping, and so on.

Qualitatively, the usefulness of reclaim can be extended today as never before, according to rubber technicians. This extension will be over and above that which the war emergency would dictate, because reclaim is being produced in grades suitable to more uses than heretofore. Quality and uniformity are under much more strict control and reclaims of different types are being made to meet certain standard specifications agreed upon by the reclaimer and the consumer. Processing qualities, also, have been so improved that the proportion of reclaim used can be increased without causing difficulty in the manufacture of rubber

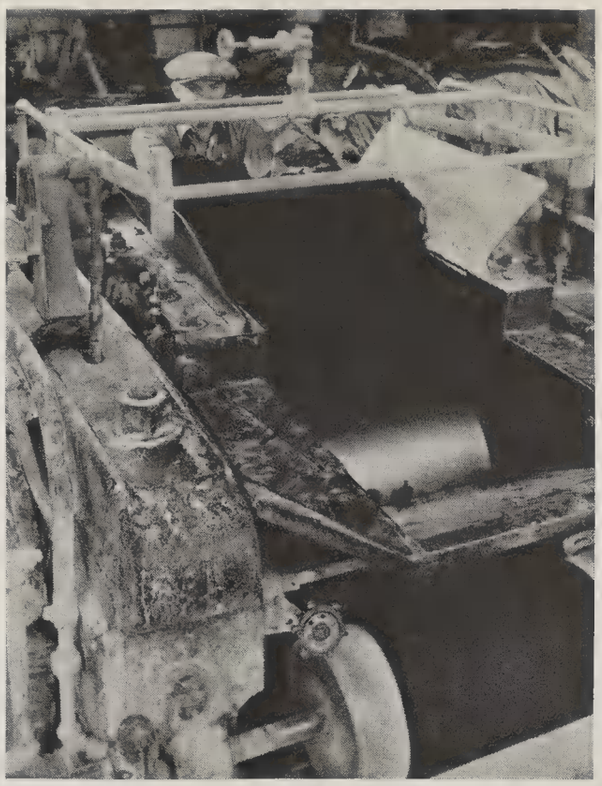


All illustrations courtesy B. F. Goodrich Company

Rubber from the mixing mill is "strained," emerges from machine looking like black spaghetti

goods by standard methods.

Parenthetically, it should be mentioned that many new uses for reclaim are becoming highly important to the industry. One of the most recent is an extensive use of reclaim in aqueous dispersions. These dispersions might be considered as synthetic counterparts of latex, except that they may be derived from either reclaim or crude rubber. Present commercial applications of these dispersions, which are quite similar to those of latex, nearly all make use of reclaim. Such dispersions are available in various colors and compositions, varying in concentration, stability, and other characteristics. It is stated by rubber technicians that the new uses for reclaimed rubber dispersions now account for a substantial consumption of reclaim.



On bottom roller is the reclaimed rubber being rolled and made into slabs for use by the trade

Unfortunately for the process of collecting old rubber from widely spread points, it is those items that do not bulk very large that are of the most value for reclaiming. Things like hot-water bottles, crepe soles, inner-tubes, bathing caps, and so on, are almost ideal for the processing and yield the highest quality of reclaim. Bulkier things such as door mats, boots and overshoes, running board mats, and so on, are less valuable. Many of these latter, because they already have so much reclaim in them, are good only for conversion into rubber products of similar properties. Auto tire casings rate in the middle group of these extremities of scrap preferability. They are not as useful as inner-tubes and the crepe rubber soles, but they are better than door mats and overshoes. On the average, a ton of better grade scrap will produce ¾ of a ton of reclaim.

Articles of hard rubber—battery cases, combs, and the like—are not reclaimable at all. They have such a high proportion of sulfur, carbon black, and other minerals in their original compounding that the natural rubber molecules have been all but smothered.

During recent months the production capacity of the reclaim industry has been substantially increased. This has been accomplished by increased efficiency in production, coupled with high-operating rates, and by installing such new equipment as was needed to balance production throughout the plants. It appears that the reclaim industry as a whole is in a position to meet the demands of abnormally high consumption of its products, provided, of course, that the scrap material needed for processing flows into the plants in a steady stream.

[NOTE: At the time of going to press there is considerable discussion in Washington on the matter of tires for civilian use, composed largely of reclaim, plus a very small percentage of crude, plus relatively large percentages of synthetic rubber. It is claimed that these tires can be manufactured without interference with the supplies of needed rubber for military requirements. Nothing has been proved so far, however, and unless the situation changes materially before this issue reaches the readers, the foregoing paragraphs relating to tires for civilian use still stand.—*A.P.P.*]

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NEW STEEL

Makes Use of No Critical Alloying Elements

IN the fuselages of certain airplanes, seamless tubing of cold-drawn chromium-molybdenum alloy steel is used because of its great strength. Chromium, however, is now on the critical list.

If certain experiments now well advanced in one steel company turn out to be successful, and the aircraft steel specifications are accordingly changed, another alloy steel may be used for the purpose. It contains no chromium and, indeed, requires no virgin alloying elements of any kind. The alloys used are all obtainable from scrap.

Furthermore, experimental lots of tubing, produced by electrically welding flat strips into tubular form, have proved to be as strong and dependable as the cold-drawn, seamless tubing now in use. Electric-welded tubing not only can be produced faster than seamless, but plenty of equipment to produce it is available in steel companies.

POLISHING BRUSH

Eliminates Stress Concentration Points

A NEW polishing brush that has the unique job of increasing the safety of fighter planes by eliminating peculiar "stress concentration points" on metal surfaces is reported to be the product of the careful analysis of 70 serious airplane crashes occurring in the United States during a period of several years.

According to R. O. Peterson, manager of the technical department of The Osborn Manufacturing Company, the brush is being produced in large quantities for manufacturers of airplane engines and engine parts under pressure of government demands.

After a study of the 70 crashes, scientists found they were due to failure of some moving or vibrating part in the plane, Peterson says, stating that he became convinced that the essential cause in most instances could be attributed to the existence of stress concentration points on the metallic surfaces.

"These points," reports Mr. Peterson, "may be nothing more than sharp scratches or nicks on the surface, not much more than eight one millionths of an inch deep. They may be tiny burrs or grooves left in machining. When stress, especially that due to high-frequency vibration, is placed on a machine part having one of these defects, the stress is concentrated there. From one of these tiny points a crack may begin that will end in a fatal plane crash. When a crack starts, it follows along the surfaces of the crystals that make up the structure of the metal. Even if a stress concentration point is situated in the strongest portion of a machine part, this defect may be a cause of failure."

Investigators found that ordinary polishing would eliminate these points satisfactorily, if they were in accessible places, but many surface areas that required polishing could not be reached by ordinary polishing equipment. More

flexible tools were required, and Peterson and his assistants at Osborn found that a brush of tampico fiber could do the work required. This met with the approval of the Army and Navy inspectors. The brushes are made in the form of cylinders or flat disks and are given a treatment with a special form of stiffening liquid to prevent their

Brush makes fighter planes safer

fluttering while in motion. The polishing material used with the brushes is usually a very finely powdered alundum, fine enough to go through a 240-mesh screen, and suspended in a suitable pasty material.

The polishing accomplished by means of the brush eliminates stress concentration points much more effectively than other polishing devices, Mr. Peterson claims.

The tampico brush does not impart a luster as high as that given by other polishing devices, but the surface is much more suitable for machine parts. The finish is so uniform, in fact, that a special instrument is necessary to test the irregularities. Inspection is made by a specially trained observer, who makes use of reflection to detect with his naked eye irregularities on the order of eight one millionths of an inch.

WELDS PHOTOGRAPHED

For Instruction and Inspection Purposes

A NEW photographic method for inspecting welding work has been developed by C. A. Dunn, Professor of Engineering at Oklahoma A. & M. College, Stillwater, Oklahoma. Airplane factories, shipyards, and many other concerns engaged in national defense work may eventually benefit from his work.

Working in co-operation with the Eastman Kodak Company, Professor Dunn found that welds could be photographed, although many difficulties were encountered in attempting to photograph such work; and that such factors as size and shape of molten pool, arc length, indication of fusion, undercutting, and so on, could be distinguished in different quality welds. The intense light produced by the electric arc necessitated the use of a camera filter. A filter permitting only 10 percent of the light to reach the film gave the best results—clear details and little glare. Color film was also tried, but the smoke from the burning electrode made a blue color to which color film was sensitive, obscuring some important details of the welding.

The automatic camera was next considered. Although Professor Dunn learned from camera experts that there was no photographic reason why a camera could not be installed in an electrode holder, as yet the design of the photo-electrode holder has not been completed.

The present phase of Professor Dunn's research is an effort to adapt sound to the picture. The sound of the arc is useful to the welder and inspector in passing judgement on the photographic process. Professor Dunn believes that the first important use of the photographic process will probably be in training courses for student welders and inspectors.—*Engineering News-Record.*

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FILLER—A new synthetic resin binder used in knot-hole fillers has been found to increase the value of low-grade lumber and to improve high-grade lumber. Secret of this filler is that it won't shrink even when used in two-inch diameter knot-holes.

• • •

TOUGH STEEL

Armor Plate Almost Wrecks Plant

STEEL men enjoy licking tough jobs. The men in one company are especially proud of one completed job that was such a downright bad actor that for a time it threatened to wreck completely a vital piece of equipment.

The order was for a special type of armor for one of our allies—a grade of steel never before made in this country. The steel was urgently needed, so any prolonged experimentation in manufacturing methods was out of the question.

No particular difficulty came up in the process of melting the steel and meeting the specifications for chemical composition, but then the trouble started.

The steel proved to be so hard and tough that from the outset it appeared that the rolling mill would have to be operated at only one fourth its usual speed. Even that did not solve the problem, however.

As an ingot would enter between the two rolls of the mill, there would be a deafening crash, the great rolls would shudder, slow down, and finally break—disabling the mill. A new set of rolls would be installed, the speed of the mill cut still further, the amount of pressure on the ingot reduced, and the mill crew would try again—and shortly break another roll.

This kept up until the plant was down to its very last set of rolls. By that time, most of the company's top-flight production men had been mobilized for the job and they were able to figure out a proper combination of mill speed, pressure, and the various other rolling factors. On the last set of rolls available, they were able to complete the order.

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WARPING—Plywood panels constructed so that they have nearly the same stiffness in directions with and across the face grain are much less apt to warp than panels which are very limber in one direction and very stiff in the other.

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SOLDERING SPEED-UP

With Carbon Tip and Grounded Work

REPLACING a completely manual operation that formerly took a considerable amount of time and required a great deal of soldering iron maintenance, an electrically heated carbon tip has been put into use in one of General Electric's industrial control factories. In the application illustrated in one of our photographs, the carbon-tip soldering method is applied to a plate-type

Assembly-line soldering

rheostat, although it could as readily be used for other purposes where the electrical circuit can be satisfactorily completed.

In the use shown, the assembled rheostat plate is placed in a grounded fixture. The operator then lowers the carbon tip into contact with the point to be soldered, heat is quickly developed, and the solder applied and sweated in.

PRODUCTION LIGHT

Increases Give Better Vision, Better Work

AMERICA'S war effort has boosted lighting levels in modern defense plants to four times their peacetime strength, according to S. G. Hibben, Westinghouse Director of Applied Lighting. "Widespread vision defects caused by poor industrial lighting in the first World War will not recur in the present conflict because American industry is now engaged in a virtual 'battle of footcandles' to outdo enemy nations in increasing factory illumination," Mr. Hibben declares.

Since the start of the defense program, modern plants have increased lighting levels from an average of 10 footcandles to 40 and 50 footcandles, the new standard for adequate installations. These levels are 13 or 14 times greater than the average of three footcandles used by industry from 1914 to 1918. Today, these old levels of illumination would be little better than the lighting found on a busy city street.

NICKEL SAVING

In Electronic Equipment by Lining Up Crystals

ENOUGH nickel to make armor-plate for 55 medium tanks—20,000 pounds of it—will be conserved during 1942 by the Westinghouse Electric and Manufacturing Company through substitution of Hipersil steel—developed originally for electric transformers—for a nickel alloy in the manufacture of Ignitrons. These are electronic devices which convert alternating current electricity into the direct current required in the manufacture of aluminum and magnesium and for electric locomotives, steel mills, street cars, subway cars, printing plants, spot welding, and so on.

One part of the Ignitron equipment—a doughnut-shaped device known as a reactor—was formerly made of an alloy containing about 50 percent nickel. But when it became apparent that more and more nickel would be needed to make the steel alloy used in armor-plating tanks and battleships, the search started for a substitute material.

Seeking a magnetic material which did not contain scarce metals, reactors made of ordinary magnetic iron were first tried. This failed to work satisfactorily because the iron got hot and wasted too much power and failed to

Hipersil replaces nickel alloy

provide the magnetic qualities required by Ignitrons. When Hipersil steel was tried, the first reactor made with this metal not only performed as efficiently as nickel alloy reactors but turned out to be more satisfactory under changing temperature conditions.

The magnetic properties of Hipersil steel are not materially affected by temperature changes, which range in the reactors from 70 to 200 degrees, Fahrenheit. A special silicon steel, it is produced by certain melting, heat treatment, and rolling techniques that rearrange its crystals and improve its magnetic properties—a process that enables a small amount of Hipersil steel to do the job of a larger amount of ordinary electrical steel. This method of steel treatment trains the metal's invisible crystals to "fall in line" and become better magnetic paths, with the result that Hipersil steel carries one third more magnetic flux or magnetism than ordinary steel. For example, an electromagnet made of Hipersil steel will do the same amount of work as an ordinary silicon steel magnet one third larger.

FIBER CONTAINER

To Replace Cans, Made on Same Machinery

AFTER many months of experimentation, the American Can Company has developed a method for making "cans" with fiber bodies on machines used for the manufacture of metal containers. This new method, which will be made available to the entire industry as soon as it has been thoroughly tried and perfected through actual production, is considered the most important development within the can manufacturing industry during the past decade. The method brings the first ray of hope to the vast number of American manufacturers of dry products whose merchandise was packed in cans, and whose business is threatened with dislocation by restriction of metals.

The greatest merit, perhaps, of the new method, is that no new machinery is required. At a time when it is impossible to get new machinery or tools and materials with which to construct it, a method has been devised of feeding fiber sheets into existing machines geared for manufacturing metal cans and obtaining a reasonable facsimile of the old container. Another factor of merit is that the manufacturer of a product which uses the cans also may use his existing packaging machinery.

The new container will come to the rescue of those products known in the trade as "dry" such as drugs, cosmetics, spices, powders, and so on. A few liquid products may also be affected.

Under the new manufacturing method, paper will be run through the various tin can lines. The fiber, cut to sheets of tin plate size, lithographed on the regular presses formerly used for lithographing designs on tin plate, will then be sheared and formed into bodies. The black plate ends will be seamed on to the container with the regular seaming machine now in use.

SOAP FLAKES

Solve Industrial Production Problem

THE ladies who "Lux" their dainties daily may not find themselves up against priority problems quite yet because of war industry demands, but, in one instance, their soap flakes have been drafted for war production.

In broaching a hole in a pressure-pump valve part in mass production, difficulty was experienced in obtaining the desired smoothness of finish. Numerous cutting fluids were tried with indifferent success until the engineer from the Colonial Broach Company, makers of the broach, and the valve manufacturer, hit on the idea of experimenting with a solution of ordinary Lux and water. The result was completely satisfactory, the finished hole was as smooth as the ladies' dainties, and the Lux soap solution is now being used in regular production.

INDUSTRIAL TRENDS

LIFE LINES

If there is one thing this war has taught the public in general and the oil industry in particular it is that the most important factor in the whole problem of petroleum, from the drilling of the well to the use of the final product, is transportation. Too well known to warrant discussion here is the shortage of gasoline along the eastern seaboard and the threatened shortage of fuel oil for the coming winter. Everyone is familiar with the fact that these shortages are not due to any shortage of petroleum or petroleum products. It is a case of getting these materials to the ultimate consumer, the means for which are now limited by the exigencies of war.

As has been told in these pages and elsewhere, there are four main methods of transporting bulk shipments of the liquids which make up the stock-in-trade of the petroleum industry. These are the tank ship, the pipe line, the rail tank car, and the highway tank truck. Three of these have been hard hit indeed by the war. The oil tanker has found an implacable enemy in the submarine, the railroads are overburdened by the demands of shipments of other materials of war, and the tank trucks—smallest units in the transportation system—do not have the physical capacity to take over much of the burden and are getting short on the rubber tires so sorely needed for their continued operation.

This leaves the pipe line as the one method of getting liquids from here to there that is still functioning full-time in its original role. Unfortunately, however, this method is one that has, for one reason and another, not been developed sufficiently to carry the full brunt of the present situation. Ever since the first pipe line was built some 75 years ago, this method of transportation has been subjected to the indignation and bitter enmity of, in early days, the teamsters and, then as well as later, of the railroads and water-borne carriers. If it were not for this enmity there would undoubtedly be ample pipe-line capacity for all requirements and there would not now be any question about oil or gasoline shortages in some localities.

Be that as it may, even the tens of thousands of miles of pipe lines that are in active use today are still not sufficient to act alone as carriers of all the petroleum products demanded by the public, let alone the requirements of the armed forces. Thus it is that, because various elements opposed—and still oppose—the construction of pipe lines, this country finds itself with a surplus of petroleum products in some regions and a complete dearth in others.

When the economics of oil transportation are considered, it is a wonder that even the powerful opponents of the life lines of the petroleum industry were able to hold down the construction of pipe lines as much as they did. A pipe line is tucked away safely underground. It works 24 hours a day, seven days a week. Its operation is not hindered by ordinary storms and it is relatively cheap to build and operate. Many hundreds of miles of pipe lines can be built in the length of time required for constructing a tank ship and, averaged out over a long period of time, the pipe line will carry more oil per year than will the tanker.

Here's about how the figures work out. Although a tanker may carry up to 150,000 barrels per trip, the vicissitudes of the sea, and the distances involved, are such that a tanker with this capacity will average only some 4000 barrels per day, on a yearly basis. This is estimated on the average Atlantic Coast run. On the other hand, a 12-inch pipe line can handle some 60,000 barrels per day and can continue to do so with a regularity that spells fuel to consumers wherever the lines are available and as long as the pumps continue to operate.

Although tens of thousands of miles of pipe lines were mentioned a few lines back, it is necessary to understand what these lines are used for in order to appreciate the over-all picture of this phase of one of our most important industries. First, there are some 54,000 miles of gathering lines that carry the crude from the fields to the trunk lines. These latter, about 62,000 miles in total length, move the crude to refineries, storage tank "farms," and even to railway and ship terminals for further handling. About 10,000 miles of lines carrying refined products—gasoline, lubricating oil, and so on—complete the total of oil pipe lines. These products lines, by the way, are a comparatively recent innovation in the industry. Originally, pipe lines carried crude alone. Then, only a decade or so ago, gasoline was transported for the first time by pipe. Still later other products were pumped through pipes and, today, it is the products pipe line that is receiving the greatest attention. Such a line may carry, by correct manipulation of the control equipment, Diesel fuel, any one of many grades of gasoline, kerosene, lubricating oil, or other petroleum products. This flexibility is of distinct advantage to the operating companies and the products line is a development that has a promising future. Innovation that it is, there is every indication that the products line is so successful in operation that more and more of them will come into existence by conversion of crude lines. The probabilities are, also, that the end of the war will find this type of transportation so firmly intrenched in the petroleum industry that, as soon as materials are available once more, products lines will spread over the map of the United States like oil on water.

A hint as to the future possibilities of pipe lines in petroleum transportation of all kinds is to be found in the activities of securities analysts when they evaluate investments in the petroleum industry group. They pay careful attention to the pipe line holdings of the companies under consideration, thus pointing directly to the value of these lines now and in the future.

CARGO BY AIR

Something to get excited about, as seen from this vantage point, are the future possibilities of transportation of cargo by air. Dr. Klemin, our aviation editor, has treated this general subject in his monthly notes, and many far-seeing designers are working steadily on the special problems involved.

One thing to keep in mind when considering this specific trend in the aviation industry is that, according to informed engineers, it will not be practical, when peace comes, to convert military planes to cargo operation. Planes for fighting purposes, whether they be pursuits, bombers, or what-not, are designed for high performance with little or no thought of economy of operation. For the cargo plane of the future, performance will become entirely secondary, and main emphasis will be placed on economy. So long as the plane has high speed and safety and can fly long distances with fuel economy, it will have at least an even chance of competing with other forms of transportation. Thus, completely new designs are and will be forthcoming.

—The Editors

The Scanning Electron Microscope

High Magnifications of Opaque Objects With New Instrument Combining Developments in Many Fields

Dr. VLADIMIR K. ZWORYKIN
Associate Director, RCA Laboratories

IMAGES of objects may be formed in two basically different manners. Either the picture as a whole may be projected simultaneously on the recording surface, as typified by the photographic camera, or it may be formed by the sequential recording of its elements, as a painting takes shape under the successive brush strokes of the artist. Practically all optical instruments, including the standard RCA electron microscope, utilize the first method for image reproduction. Television and electric picture transmission or facsimile, on the other hand, analyze the picture to be transmitted into a large number of minute picture elements, successive signals derived from adjacent elements, and proportional to their brightness, serving to control the intensity distribution in the re-synthesized image on the viewing tube screen or recorder paper. The scanning electron microscope belongs to the same class of image-forming devices.

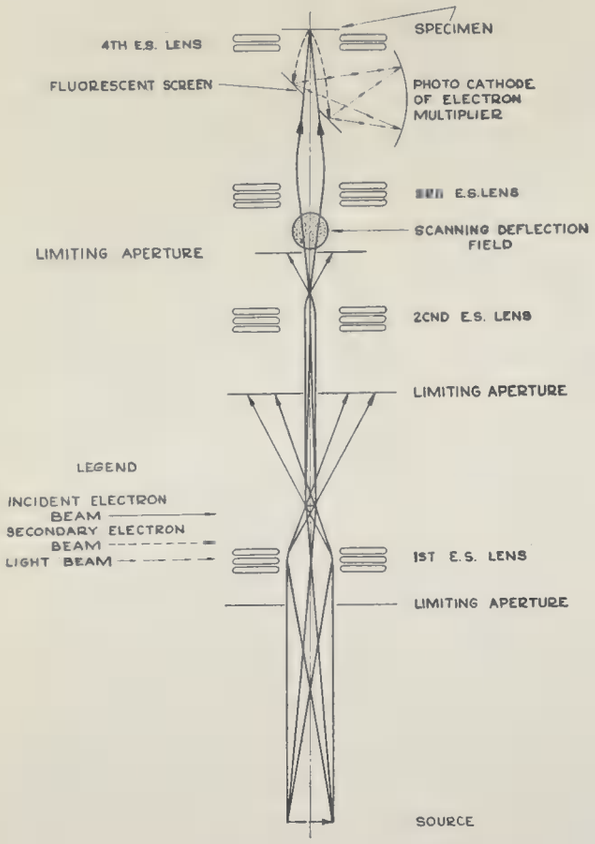
The special sphere of usefulness of the scanning electron microscope lies in the observation of surfaces of opaque objects, just as the standard electron microscope is primarily adapted for the viewing of transparent specimens. The boundary between transparency and opacity for electrons of the order of velocity normally employed in electron microscopes lies in the neighborhood of 1/100,000 of an inch. The standard electron microscope cannot be adapted to the direct observation of surfaces without a great loss in resolving power. It is thus the aim of the scanning electron microscope to extend the range of observation in metallographic microscopy as the standard electron microscope has already extended it in the bacteriological, chemical, and related fields.

Various researches concerned with the application of the methods of electronic television to problems of microscopy have been carried on in the RCA Laboratories over a period of over eight years. Thus, at an early stage a directly coupled television pick-up and receiver unit was combined with an ultra-violet microscope so as to yield a visible image of readily controlled brightness and magnification. Here the television equipment served primarily to convert an invisible into a visible image and did not participate in the formation of the original magnified image. In order to obtain a genuine scanning microscope it was necessary to replace the ultra-violet-sensitive mosaic in the pick-up tube by the object itself. If, with the latter arrangement, the scanning amplitude in the pick-up tube—that is, the scanning area on the object—is reduced, leaving the scanning in the viewing tube unaltered, an enlarged image of the object is formed on the fluorescent screen, the variation of brightness in the latter corresponding to the variation in the secondary emission sensitivity of the specimen. The magnification of the image is simply equal to the ratio of the scanning amplitudes on the object and on the screen of the viewing tube.

Etched brass, as pictured by new microscope

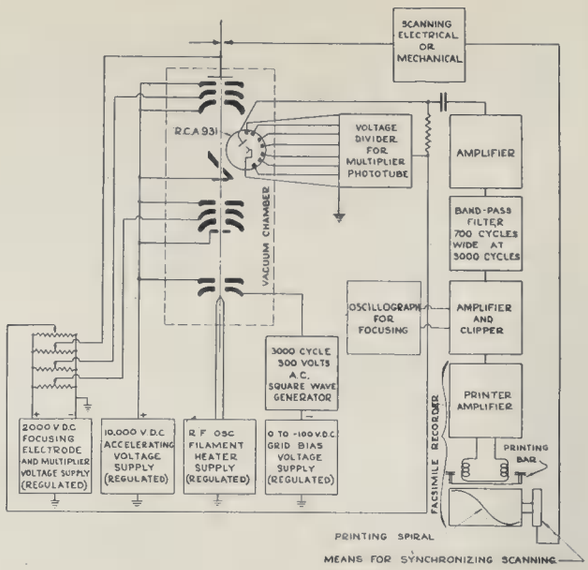
Simple as the basic principle of the scanning electron microscope may thus appear, the realization of an instrument with a resolving power comparable with that of the standard electron microscope meets very great difficulties. These arise primarily from the necessity of making the scanning spot no larger than the least separation which is to be resolved—that is, no larger than approximately one two-millionth of an inch (or 100 angstrom units) in diameter. A spot of this size may be realized by forming a reduced image of the "crossover" in front of a hot cathode by two short-focus electron lenses operating in two reducing stages; in short, the source is placed at the center of the image plane of a high-power compound electron microscope, the spot being formed where, normally, the object is located. As the electron lenses of this "microscope" are afflicted with spherical aberration in the same manner as other electron lenses, the requirement of a fine spot demands not only a high reduction ratio, but also a restriction to very narrow imaging beams. It may be shown that under these circumstances the current in the spot of the required size has a fundamental upper limit of the order of one millionth of a microampere. The variations in the secondary emission of the specimen which are responsible for the image detail may normally be expected to have an amplitude of the order of 1/10 of this amount.

IF it should be attempted to amplify this signal current of 10^{-13} amperes or less with a regular television amplifier, and to apply the amplified current to the control grid of a television receiving tube, no picture whatever would be obtained—the picture detail would be completely lost in picture "noise" since, with the speed of scan-



Left: "Ray" diagram of the scanning electron microscope, showing beams and lenses

Right: Schematic arrangement of the various parts of the scanning electron microscope


SCANNING ELECTRICAL OR MECHANICAL
RCA 931
VOLTAGE DIVIDER FOR MULTIPLIER PHOTOTUBE
AMPLIFIER
BAND-PASS FILTER 700 CYCLES WIDE AT 3000 CYCLES
VACUUM CHAMBER
OSCILLOGRAPH FOR FOCUSING
AMPLIFIER AND CLIPPER
3000 CYCLE 300 VOLTS A.C. SQUARE WAVE GENERATOR
PRINTER AMPLIFIER
PRINTING BAR
FACSIMILE RECORDER
2000 V.D.C. FOCUSING ELECTRODE AND MULTIPLIER VOLTAGE SUPPLY (REGULATED)
10,000 V.D.C. ACCELERATING VOLTAGE SUPPLY (REGULATED)
R.F. OSC FILAMENT HEATER SUPPLY (REGULATED)
0 TO -100 V.D.C. GRID BIAS VOLTAGE SUPPLY (REGULATED)
PRINTING SPIRAL
MEANS FOR SYNCHRONIZING SCANNING

ning required, only about one secondary electron is given off on the average by each picture element, making it quite impossible to transmit information regarding a fractional variation of the secondary emission sensitivities of the picture elements.

Accordingly, although scanning microscopes of relatively low resolution (down to 1/20,000 of an inch or one micron) were successfully constructed even with the image observed directly on the fluorescent screen of a kinescope, high-resolution instruments required a slower method of recording. A facsimile receiver, registering an image in eight minutes (as compared with 1/30 of a second for a television receiver), proved to be a satisfactory solution. By this means the number of electrons emitted per picture element was increased by a factor of about 6000, the total number of picture elements in the image being, simultaneously, doubled.

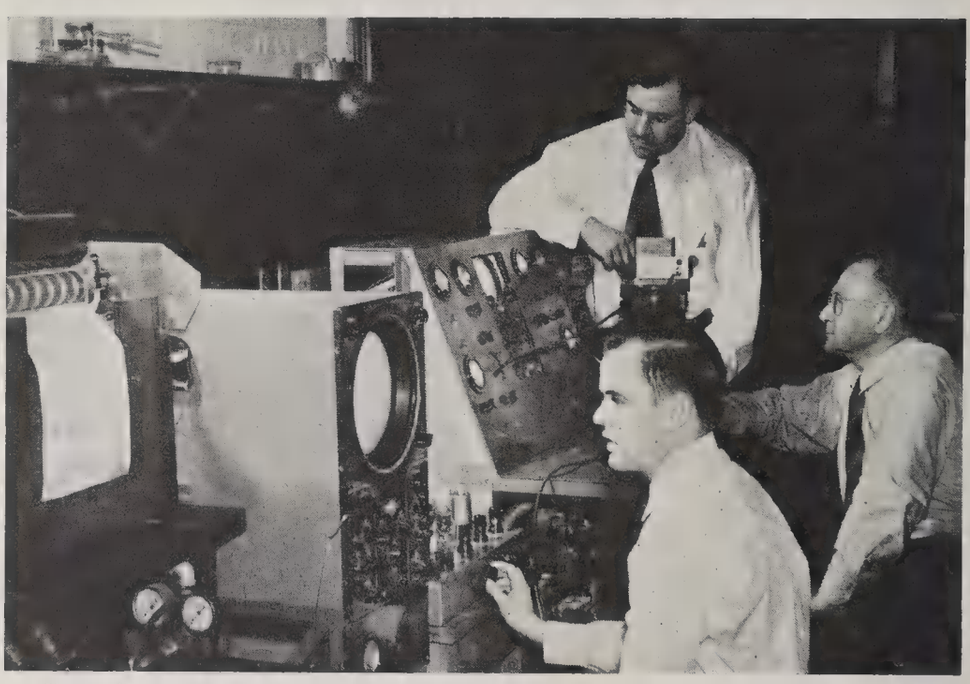
EVEN so, a satisfactory image could only be obtained by the employment of a practically noise-free amplifier—the electronic secondary emission multiplier tube. The secondary electrons, in place of being collected directly, are permitted, after suitable acceleration, to fall on a fluorescent screen, whose light emission is concentrated on the photo-cathode of the multiplier. By matching the spectral sensitivity variation of the photo-cathode to the emission bands of the fluorescent material it is possible to attain a photocurrent in the multiplier which exceeds by a considerable factor the electron current incident on the fluorescent screen.

The general arrangement of the scanning electron microscope is shown schematically in one of the drawings; certain modifications of this arrangement, incidental to a replacement of mechanical scanning by magnetic scanning in the final instrument, are evident on the "ray" diagram.

Referring to the general arrangement drawing, the electron source, at the bottom of the microscope, consists of a thin tungsten wire fed by a regulated radio-frequency power supply. It may be oriented with respect to a two-element electrostatic lens comprising the grid and the anode of the electron gun by means of three micrometer screws. A 3000-cycle square voltage wave is applied to the grid so as to give the beam, and hence the signal current, a 3000-cycle modulation. In addition to this, a variable D.C. grid bias is provided to regulate the current in the beam.

The anode, as well as the remainder of the channel through which the beam passes, with the exception of the center electrodes of the two reducing lenses and the specimen itself, is normally maintained at a potential of 10,000 volts with respect to the cathode, the voltage supply being stabilized by negative feedback to within .001 percent.

After traversing two masking apertures, the beam passes through the first electrostatic reducing lens, which forms an image of the crossover of the beam, the reduction factor being of the order of 50. It may be adjusted by varying the potential of the center electrode with respect to the cathode, a stabilized 2000-volt supply being provided for this purpose. About halfway between the first and second lens, at the end of a narrow tube acting as



Shown here with the recently perfected scanning electron microscope are Dr. James Hillier (foreground), Richard L. Snyder, and Dr. Zworykin, the author, at the right

an electrostatic shield for the beam, is another aperture of the final lens, placed approximately at the center of an inclined fluorescent screen. The final lens, similar in construction to the first lens, forms the scanning spot, imaged on the specimen. The latter may be translated in three directions in the same manner as the source.

On striking the specimen, the primary electrons eject secondary electrons from it. These have low initial velocities, corresponding to accelerating voltages between 0 and 10 volts. The strong accelerating field between the specimen and the uppermost electrode of the final lens draws them back through the final lens, which focuses them at some point between it and the inclined fluorescent screen. Due to the smaller initial velocity of the secondary electrons, the lens action of this lens is much stronger for the secondary electrons than for the electrons of the original beam. The secondary electrons, diverging from their point of focus, form too wide a beam to pass through the fine aperture in the fluorescent screen. They fall on the screen instead and their energy is, to a considerable extent, converted into the bluish light characteristic of the luminescent substance employed. A large fraction of this light falls on the photo-cathode of the electron multiplier placed in a favorable position relative to the screen and gives rise to a photo-current which, suitably amplified and filtered, forms the signal current controlling the printer bar of the facsimile recorder.

In the earlier instruments the scanning was accomplished by the mechanical displacement of the specimen, the motion of the latter being linked electrically or hydraulically with the displacement of the recorder drums with the aid of suitable cams mounted on the axes of the drums. Since adequate precision in the scanning could not be obtained by this means, magnetic scanning was provided in the final instrument. The deflecting yoke is placed directly below an auxiliary lens of approximately unity magnification, the primary purpose of the latter being to provide space both for the deflecting yoke and the fluorescent screen. After passing through a hole in the screen the primary beam traverses a decelerating lens and strikes the object. The returning secondaries spread out over an area about the hole, causing the screen to fluoresce in proportion to the intensity of the secondary emission current. The light from the screen, finally, is concentrated by a wide-aperture lens on the photo-cathode of the multiplier. The area of the specimen which is scanned is normally only about 1/1000 of an inch in diameter.

A picture of an etched brass surface obtained with the scanning electron microscope is reproduced in these columns. The resolution is here of the order of 500 angstrom units, representing a great improvement over the optimum obtainable with the light-optical metallographic microscope. As with any new device, it is not possible to judge the full range of utility of the scanning microscope at the present time. It is an interesting fact, however, that its perfection has been made possible only by a large number of concurrent developments encompassing the fields of television, facsimile, secondary emission multipliers, fluorescent materials, and electron microscopy.

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METAL DETAILS

Reproduced in Film for Electron Microscopy

PLASTIC films one five hundred thousandth of an inch in thickness, equal to about a tenth of the length of yellow-orange light waves, have been found best by General Electric scientists for revealing details of metal surfaces under the electron microscope. A full account of the technique by which these films are made and used is published in the *Journal of Applied Physics,* in an article by Vincent J. Schaefer and Dr. David Harker.

After the metal sample is polished and etched for a few seconds with acid, it is dipped into a dish containing a solution of Formvar, a plastic, in dioxane, a commercial solvent. The authors point out that it is necessary to do this within a few minutes after the sample has been etched and dried. Otherwise an infinitesimally thin film of grease or other contaminating material may start to form.

After dipping in the Formvar solution, the solvent evaporates, leaving the plastic film, which is then stripped off, and on which are reproduced the microscopic hills and valleys of the metallic crystals. The film can then be placed in the electron microscope for examination.

Mr. Schaefer and Dr. Harker find that the exact thickness of the Formvar film is important, and this can be regulated by the strength of its solution in dioxane. Very thin films, about a millionth of an inch, do not show much contrast in the final electron picture. This seems to be because the film both on top and bottom follows the hills and valleys of the metal. Thus it is all nearly equally transparent to the electron beam. If the film is as thick as 1/250,000 of an inch, contrast is also poor.

Best thickness is around 1/500,000 of an inch. Such films are just thick enough to make the top of the film level, while the bottom reproduces the hills and valleys.

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HEAT—A temperature of 45,000 degrees, Fahrenheit, has been momentarily produced at the National Bureau of Standards by discharging, through a quartz tube with a one-tenth inch bore, 40,000 kilowatts of electrical energy over a period of five millionths of a second.

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WOMEN IN SCIENCE

Interest In Tackling Problems Is Essential

THERE are plenty of opportunities for women in science, and an interest in tackling problems is essential for those who want to take up such work, according to Dr. Katharine Blodgett, physicist of the General Electric Research Laboratory.

"The requirements for work in a laboratory are not so different from the requirements for successful work in any vocation," she said. "For laboratory work you need formal training, of course; and, in addition, you need persistence, patience, and a knack at solving problems—and the most important of these is the knack at solving problems.

"Often college students come to my laboratory to ask if I think they would make good laboratory workers. They are complete strangers to me—I do not know if they would make good laboratory workers. And so I ask a student this question: Is she interested in tackling problems—not just laboratory problems, but everyday problems outside of the laboratory—all those commonplace, unexpected, and sometimes unenviable problems that come up that somebody has to solve? For example, if the plants in the garden at home are being eaten at the root by cutworms; or if she has caught her dress on a nail and doesn't know how to mend the tear; or if her favorite summer camping spot is becoming carpeted with poison ivy—does she tackle the problem?

"There are people," Dr. Blodgett continued, "who are never interested in solving problems. I think that one reason is because they never outgrow the childhood complaint of saying, 'I can't,' which is just another way of saying, 'I won't try.'"

The Nebular Spectrum

More Impressive Grows the Evidence for the Uniformity of Composition of Matter in Space

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ONE of the ablest of the younger group of American astronomers, Dr. Arthur B. Wyse, lost his life in the service of his country on June 9th in the collision of two naval airships. The nature of the technical problem upon which he and several colleagues in other sciences, who were also lost, were engaged has not been revealed. But the record of his astronomical work, in the brief span of nine years, provides a worthy and permanent memorial.

Twice within the last few months we have had occasion to describe, in these columns, work in which he had a share. He was the first to discover the remarkable bright lines in the spectrum of RW Tauri, which later revealed the existence of the ring of gas rotating around it, of which we told in July, and his skill in intricate mathematical analysis had a large part in the successful interpretation of the rotation of the Andromeda nebula, and its neighbor spiral, Messier 33, which we described in June.

His principal contributions to science, however, were in the study of spectra. Three years ago, he and Dr. Bowen—the discoverer of the nature of the "forbidden" nebular lines—published an admirable study of the spectra of three bright planetary (gaseous) nebulae, finding for the first time evidence that atoms of metals as well as of permanent gases were present in them. A continuation of this work, extending the observation of ten nebulae, was fortunately completed by Dr. Wyse just before he left the Lick Observatory for war service, and was published but a few days before his death. Quite apart from this tragic interest, it well deserves our consideration this month for its inherent scientific quality.

Nine of the nebulae included in this study are "planetaries." Few, if any, more inappropriate adjectives have survived from old times to confuse modern astronomical language. These nebulae show visible disks, sometimes of considerable size, and thus far have a slight resemblance to planets; but the resemblance goes no further, for they are usually oval, and often considerably irregular, in shape. Practically all such nebulae possess a central nucleus, appearing like a faint star, much brighter on photographs than when observed visually. There is conclusive evidence that they are actually shells of gas, enormous in size and of excessively low density, which surround the nucleus, and are set shining by the effects of very short-wave ultra-violet light emitted from the nucleus. The nuclei themselves appear to be exceedingly hot stars—the hottest so far known. The tenth of Wyse's nebulae was an object of very different type—the Great Nebula in Orion—a huge chaotic mass of luminous gas, of very irregular form, which is set shining by radiation from a group of bright hot stars near the middle.

THE main purpose of the investigation was to observe as many as possible of the faint emission lines which are known to exist in these spectra, and all known light-saving devices were applied. For example, the image-slicer, which concentrates the light from different parts of the nebula into narrow strips of spectrum, side by side, was used on all the planetaries. (The Orion nebula is so big that this was not necessary.) In an ordinary spectrograph, much light is lost by reflection at the many successive surfaces of the lenses and prisms through which it must pass. By coating these surfaces with exceedingly thin transparent films of fluoride of lithium or of magnesium —evaporated upon them in a high vacuum—the reflection loss was so much reduced that the photographic speed was more than doubled. An additional gain was made by increasing the sensitivity of the plates by exposing them to mercury vapor shortly before use.

All these devices together did not escape the astronomer's usual requirement of long exposures—they made these give better results. For almost all the nebulae two exposures of from 14 to 19 hours' duration, on two or three successive clear nights, were made—one for the red, the other for the violet end of the spectrum. The brightest lines could be recorded in a few minutes. A limit to the search for faint lines is set by the fact that most of the nebulae show a faint continuous background of emission spectrum. In some, this comes from the nucleus, but in others—notably in the Orion nebula—from the nebulosity itself.

To show faint lines against this background can best be achieved by using a spectrograph of quite different proportions from those employed in the study of faint extra-galactic nebulae. The latter have a camera of very short focus, so that the spectrum on the plate is but a small fraction of an inch in length. The resulting concentration of light is just what is needed to bring out a faint continuous spectrum crossed by dark lines. But in the nebulae the lines are bright, on a less luminous background. Here it pays to use a rather high dispersion. This draws out the continuous spectrum, and makes it fainter, while the images of the narrow bright lines are set farther apart, but are no wider, and so they are easier to see.

THESE pains were well rewarded. Wyse's final list contains 351 bright lines, observed in one or more of his ten nebulae between 3704A in the near ultra-violet and 6755 in the red. Some of these were observed only in a single object, at the very limit of visibility. Omitting these (which were included to make a complete record) the list contains about 270 bright lines which are undoubtedly present in the spectra of gaseous nebulae, or of their nuclei. This is three times as many as were known when the investigation was begun by Bowen and Wyse in 1938. The great lenses of the Lick 36-inch refractor, with which the observations were made, are practically opaque to ultra-violet light below 3700. With reflecting telescopes, aluminized mirrors, and quartz prisms, many additional lines have already been found in the ultra-violet, and the extension of the thorough survey would probably raise the number of known nebular lines well toward 350. Observations with plates sensitive to the deep red and infra-red, both by Wyse and by others, have revealed very little.

On the whole, the spectra of the ten nebulae are remarkably similar.

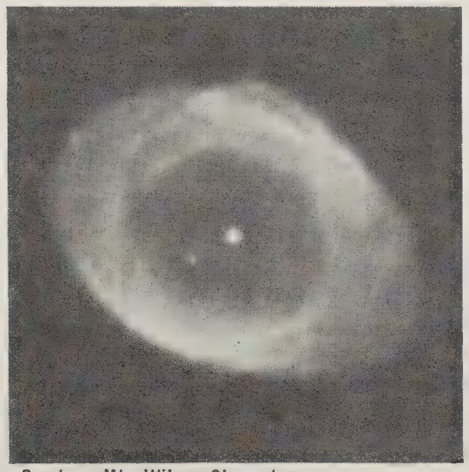
Some of them show a greater degree of excitation than others, and lines emitted by highly ionized atoms are confined to these. This may be connected with very high temperature of the central star. The Orion nebula indicates a rather low excitation.

Two close pairs of lines—of neutral nitrogen at λ5199, and of singly ionized oxygen at λ3727—are known, from calculations based on atomic theory, to be much more strongly forbidden than the rest; that is, an atom would have to be let alone much longer before it "got around" to performing the transition which produces these lines. There are one or two nebulae in which these strongly forbidden lines are brighter, in comparison with the others, than in the rest. It is very probable that these nebulae are of exceptionally low density, so that the atoms in them are less frequently disturbed by collisions with other atoms, and have a better chance of emitting the strongly forbidden lines.

When allowance is made for these factors, there remain remarkably few outstanding differences between the ten nebulae, and Wyse concludes that "the variation in line intensities, among the nebulae observed, arises primarily from differences in physical conditions rather than from differences in chemical composition."

COMBINING his results with those of earlier observations, he gives the following long list of ions represented in the spectra of one or more of the nebulae observed: *H* I, *He* I, *He* II, *C* II, *C* III, *C* IV, *N* I, *N* II, *N* III, *N* IV, *N* V?, *O* I, *O* II, *O* III, *F* II?, *F* IV, *Ne* III, *Ne* V, *Mg* I?, *Si* II *Si* III?, *S* II, *S* III, *Cl* III, *Cl* IV, *A* III, *A* IV, *A* V, *K* IV, *K* V?, *K* VI, *Ca* V, *Fe* II, *Fe* III, *Fe* VI, *Fe* VII, *Ni* VIII?. This is an impressive list in many ways. Sixteen elements have now been identified (two doubtfully) in the nebulae, including several metals, and silicon (which behaves spectroscopically like a metal). These metals show strong lines and must be abundant in ordinary stellar atmospheres. There are, however, two elements—fluorine and chlorine, which have been found spectroscopically in the nebulae, and not, so far, in the stars (except for fluorine compounds in the Sun). This is easily explained. Elements with strong forbidden lines have an enormous spectroscopic advantage in nebulae, and fluorine and chlorine are definitely of this sort. In stellar spectra, however, the spectroscopic conditions are against them. Their strong lines are inaccessible in the far ultra-violet and the only available ones would show only in hot stars.

Similar allowances for favorable and unfavorable spectroscopic conditions have to be made in the case of many other elements. When this is done, Wyse confirms, from much more extensive data, the conclusion that he and Bowen reached in 1939—namely, that the relative intensities of the spectral lines in the nebulae are very much what would be expected if their actual composition was similar to that of the atmospheres of the Sun and the stars. For a detailed discussion of individual cases, the interested reader may be referred to the original paper (*Astrophysical Journal*, May, 1942). About 40 percent of the observed nebular lines remain unidentified. Most of them are very faint, and the unidentified lines, taken together, contribute less than 5 percent of the total energy of the nebular radiation; but there is a good deal of work still to be done in finding their origin.



Courtesy Mt. Wilson Observatory

What is a planetary nebula, in relation to the total of astronomic objects? The great units of the universe are galaxies of stars of which the spirals are the most familiar. Our galaxy, the Milky Way, is one of these. Like the rest, its most familiar units are suns—billions of them. In addition, there are some oddities, relatively very small in number: diffuse nebulae (formless clouds of gas, glowing or dark) and the egregiously misnamed "planetary" nebulae (formed clouds of gas surrounding central stars). The "Ring" Nebula in Lyra, above, is one of these but it is not a ring. A sphere surrounding a central star which caused it to glow might photograph as a ring; there is more substance in the "ring" portions to send out light, a matter of geometry. As Professor Russell pointed out in December, 1937, planetary nebulae are utterly unlike planets in every way

It requires no great technical training to recognize that the metals definitely found in nebulae—silicon, potassium, calcium, and iron—are among those which are most abundant, not only among the stars, but in the composition of terrestrial rocks. It is well known, too, that the permanent gases are more abundant in the stars than are even these metals—hydrogen and helium being far ahead of the rest—and this again fits perfectly with the nebular spectra.

A few years ago, the statement that the Orion nebula was partly composed of iron would have appeared to be incredible, if not absurd. Now, 10 forbidden lines of *Fe* II, and about 15 of *Fe* III, have been definitely observed by Wyse, so that there can be no doubt about it. In the meantime, all surprise has been removed by the even more remarkable discovery that atoms of iron, very thinly distributed, form part of the gas which is distributed throughout inter-stellar space. Calcium and potassium, too, are known to be present in the inter-stellar gas.

Year by year, the evidence for the general uniformity of composition of matter, throughout the regions of space accessible to our observation, becomes more and more impressive. The Orion nebula, according to Wyse, appears to be very similar in composition to the planetaries. Yet, as he remarked, "While little is known of the origin of planetary nebulae, it seems likely that they consist of matter that has been thrown off from the central stars. The diffuse nebulae, on the other hand, as typified by the Great Nebula in Orion, have presumably never been in the form of stars."

At first glance this appears surprising, in view of the evidence that atomic transmutation occurs inside the stars and provides them with their energy. But it may be remarked that of the elements characteristic in nebular spectra, hydrogen is the as yet unexhausted fuel of the atomic process; helium the slowly accumulating ashes; carbon and nitrogen the self-renewing catalysts by whose aid the process is carried on; while oxygen, and all the heavier elements, are unaffected at the temperatures and densities which so far as we can judge prevail inside the stars.

THE light elements—lithium, beryllium, and boron—would give us diagnostic evidence. But, unfortunately, the structure of their spectra makes it certain that they can have no forbidden lines. It also is very unfavorable to detecting them at all spectroscopically (except for neutral lithium) in the heavenly bodies. The similarity of the Orion nebula and the planetaries is therefore not so remarkable after all.

One cannot close this sketch of a very beautiful piece of research without the expression of profound regret that so able an investigator has been lost alike to the service of science and of the nation.—*Princeton University Observatory, July 3, 1942.*

Pumps For Home Protection

Simple Units for Use in Combatting Incendiary Bombs and Fires Can be Made from Available Material

GEORGE H. STAHLER

A CONSTRUCTION "project" that will interest many home owners as well as civilian defense units, Boy Scout troops, and so on may be built up around home-made pumps for protection against fire and incendiary bombs.

The author has found that galvanized pipe and fittings are perfectly satisfactory for these pumps; even scrap material, if cleaned thoroughly, will serve. The drawing at the bottom of the page shows the essential parts of the pumps, the letters on the sketch corresponding to these in the specifications which follow:

Pump No. 1. A—1" by 8" pipe. B—1" by ½" by ½" tee. C—½" st. elbow. D—½" by ⅜" by ½" tee. E—½" by 1" st. elbow. F—1" by 9" pipe. Height of pump overall 34". Stirrup arrangement is separated from main board a distance of 2" and the upward opening for insertion of pump in pail is 15". The main board is 4" wide. Nozzle opening—5/64". Maximum stroke—6".

Pump No. 2. A—¾" by 8½" pipe. B—½" thread tapped inside bottom end of A. C—¼" pipe nipple which screws into tapped hole in A just above intake valve, plus a ½" pipe cap which has been drilled and tapped for the other end of nipple. D and E; a ¼" tapped hole has been made in F just above the valve. Into this hole a short ¼" nipple has been placed, to which a piece of ⅜" pipe is attached to provide a hose connection. F—¾" by 9½" pipe threaded internally at one end to provide threads into which the valve can fit. Height overall—34". Nozzle opening—5/64". Maximum stroke—6".

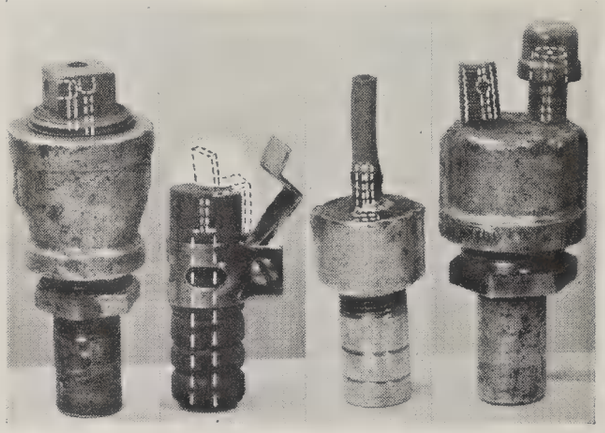
As the photographs of the valves show, a ½" galvanized pipe nipple is the basis on which they are made. To this has been added a valve seat and stopper which should be of non-corrosive metal. The top of an electric light socket may be used for the valve seat, and a brass flat-head screw or bolt for the stopper, as shown in the center valve photograph. A modification of this type, also shown, uses a brass ball, while still another employs a copper rivet. The unit at the right is a ½" pipe end used by electricians. Into it is pressed a piece of brass screen. This is used as an intake valve strainer.

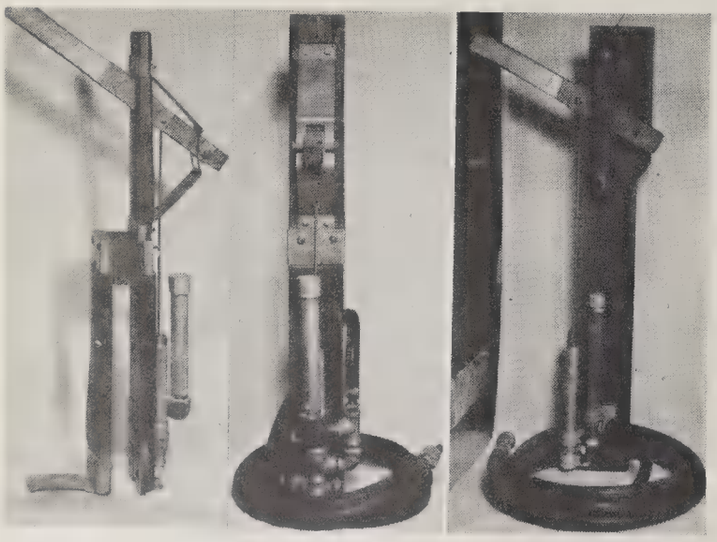
Nozzles for these pumps are show in the center photograph on this page. These illustrations are practically self-explanatory, the dotted lines showing holes drilled to produce a spray or stream as desired. In the first nozzle control is by shutting off either one hole or the other with the thumb. The body of the second valve illustrated is made from a piece of oil-soaked wooden dowel with a metal lever control. Control of the third valve is accomplished by squeezing the rubber tube, and of the fourth valve by changing the cap from one jet to the other.

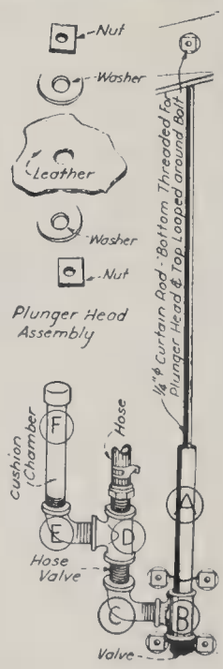
Four valves and strainer

Both of these pumps are designed to be used with 12 feet of ⅝" garden hose.

[More complete data on these and other types of pumps are available from the author. Address him in care of this magazine.—*The Editor.*]







Below: At left, side and front views of pump No. 1. At right, pump No. 2. *Drawing:* Essential parts of both pumps, with letter references to the text. *Above:* Four types of home-made nozzles.

BOMB SNATCHER

An Effective Tool for Handling Incendiary Bombs

To get rid of incendiary bombs before they have a chance to do damage is the object of the "Bomb Snatcher," made by the McGraw Electric Company, shown above. A lever controls the two semi-cylindrical refractory-lined jaws.

SIMPLE PUMP

No Strategic Materials Enter its Construction

A COMMERCIAL pump for home protection against incendiary bombs and fires, designed to replace the conventional stirrup pump which requires priority materials, has been developed by The Zadig Patents. This unusual new pump, shown at the right, is made entirely of wood and fabric, even the two lengths of hose containing no rubber. The operator stands on the base of the pump when using it and works the handle back and forth. The handle can be detached and the pump folded flat for storage when not in use.

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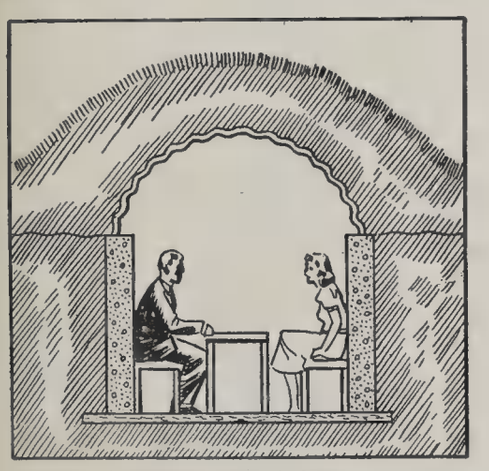
Air-Raid Shelters

Primary Consideration Should be Given to the Possibilities of Private Types of Shelters

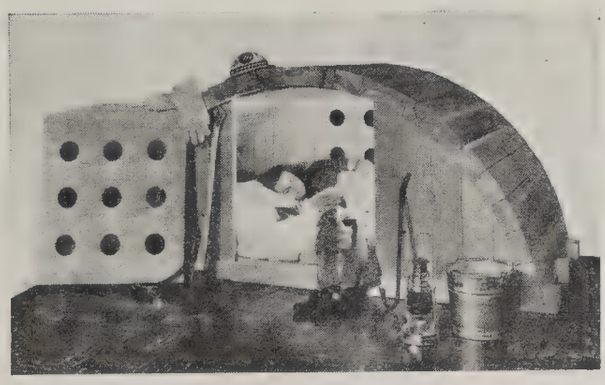
A. D. RATHBONE, IV

WHEN and if the bombs come to American cities, there will not be enough air-raid shelters for everyone who thinks he should be in one.



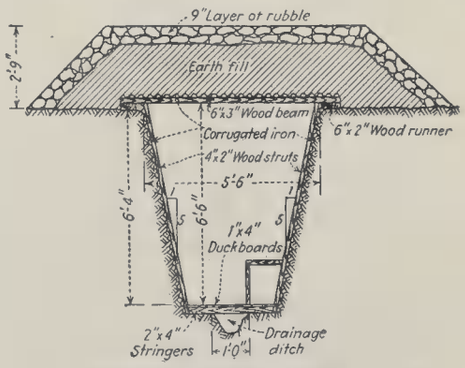
Above: Anderson type of domestic shelter. Inexpensive and effective against blast and splinters. Poor on heat, sanitation. Reproduced by permission from "What the Citizen Should Know About Civilian Defense," by Messrs. Binger and Railey, published by W. W. Norton & Co.

Right: Solid Timber Shelter, for indoor use, has room for standard double bed mattress, with space for equipment at both ends. It is constructed of non-priority materials throughout

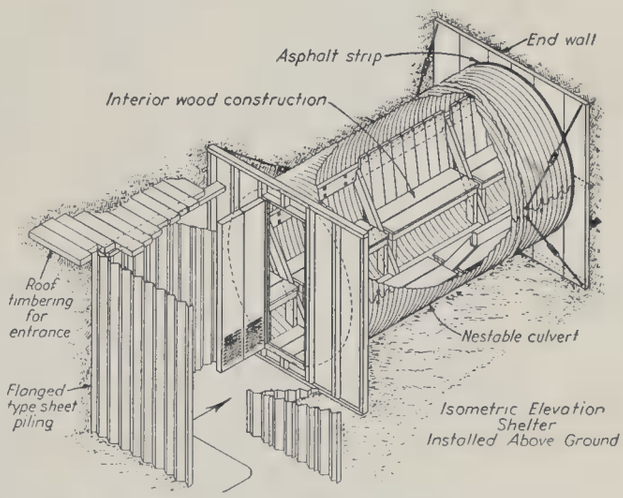


We have no time, labor, or materials to spare from war production for the construction of public shelters in sufficient number and variety to offer even the minimum of safety for all civilians on coastal cities, not to mention inland manufacturing centers. Furthermore, and contrary to popular American belief, we don't need *public* shelters. After 12 months of the most intensive bombings, England found the risk of death from the air was only about six times that of death from automobile accidents. Current writers on civilian defense report that British experience with public sleeping shelters has produced more negative arguments than positive for the well-being of the public—they are dangerous to public morale, liable to cause development of psychoses, and tend toward heavy concentrations of civilians, rather than toward the safer policy of dispersion. A census, taken in January, 1941, showed but 5 percent of London's population using public shelters, only 19 percent utilizing communal or domestic types. The rest slept in their own beds.

Inasmuch as Mr. Average Citizen is not going to find a specially constructed shelter at every street corner, what precautionary measures should he take? First, arrange for protection at home, for that's where Mr. Average Citizen spends most of his time each week, that's where his family is most likely to be, and, if he or any member of his family should be away from home when bombs come, there are just two simple rules: (1) Avoid panic; (2) Obey instructions from police, firemen, air raid wardens, or other qualified protective forces.



A covered trench shelter, from "Civil Air Defense," by Prentiss, by permission of Whittlesey House



Armco 72-inch diameter nestable pipe air-raid shelter, reproduced from "Aerial Bombardment Protection," by H. E. Wessmann and W. A. Rose, published by John Wiley and Sons

In his book, "Civil Air Defense," Col. A. M. Prentiss states: "The importance of home protection is appa-

(*Please turn to page 141*)

Buckets of Blood . . .

Your Blood Donation, an Absolutely Painless Procedure, May Help Save a Warrior's Life

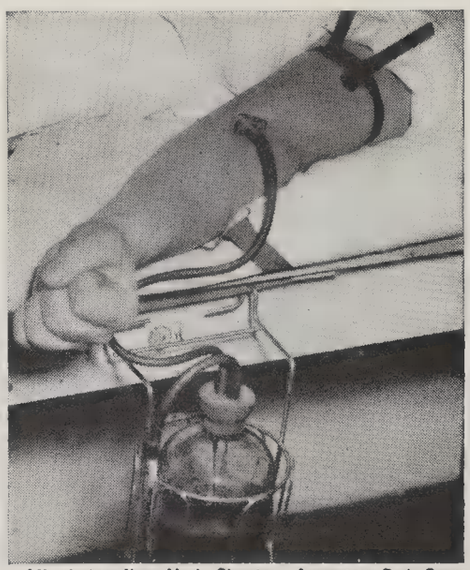
HOWARD C. FORST

IMAGINE a train of 18 railway tank cars filled to capacity, not with gasoline or other conventional cargo, but with human blood. This, were it to retain its original bulk, approximates the space which would be required to transport the blood reserve now being gathered for use by the United States Army and Navy medical staffs. 1,215,000 units is the figure which expresses the actual quantity—a unit being about one pint, the average amount taken from a donor in the course of a single transfusion.

Volunteers stream steadily through Red Cross headquarters in all cities where blood donations are accepted, New York alone accounting for more than 400 daily. The entire procedure—harmless, painless, and devoid of virtually all discomfort or unpleasant after-effects—requires only about half an hour; the transfusion itself, not more than ten minutes. Upon its completion, the donor returns immediately to normal activities, unmarked by his experience save for a small pat of adhesive tape on the inner side of his elbow joint, and the memory of a merciful contribution which may well save an otherwise lost human life.

Down through the centuries, physicians have fumbled with the idea of curing the sick with potions or injections of blood from the healthy. Though such efforts resulted often in serious after-effects or even death for donor and recipient alike, there were occasional outstanding successes—rare to be sure, but frequent enough to taunt the curiosity of the scientist, and to keep alive his interest in transfusion. Then, in 1900, Karl Landsteiner, a young Viennese bacteriologist, began a series of experiments, mixing blood serum and red corpuscles from different individuals—serum being the liquid which remains after clotting. Shattering accepted theory of that day, which held that all human blood is identical in structure, these experiments led to the ultimate emergence of the now well-known four blood groups or types, each of which is quite distinct from the others. The red corpuscles of each group contain substances which react unfavorably when serum from another group is introduced into the circulatory system. Thus, the disastrous outcome of most previous transfusion attempts had been due in large measure to this random intermixture of opposing blood substances.

In the light of this surprising discovery it seems strange that, for the better part of two decades, little attention was given the therepeutic value of properly grouping blood donors



All photos New York Chapter, American Red Cross
Taking donor's blood. Painless

and recipients. During the first World War, however, the procedure was adopted by the A.E.F. and proved highly beneficial. General acceptance followed quickly and before long the treatment was applied for a wide variety of conditions, running the alphabetical gamut from "bleeding in haemophelia" to "wasting anemia."

Until less than five years ago, the chief difficulty in the way of transfusion therepy lay not in failure of physicians to appreciate its merit, but rather in the very conditions which so often created most imperative need for its application. Frequently, where blood was urgently required—as in major disasters—a ready supply of suitable donors was not available.

Gratifying results had been obtained in a few cases by transfusing only plasma—a blood liquid differing in but minor chemical degree from serum. Unlike whole blood, which was known to be unfit for use after a week's storage, plasma could be preserved from six months to a year, and had the additional advantage of being safe for transfusion without the necessity of typing. Serious laboratory experiments were forthwith begun, and soon, again, the ill wind of war intervened to blow humanitarian good. The 1940 London bombings, with their consequent heavy civilian casualties, pressed home the need for readily available and easily transfusable quantities of blood. To such demands plasma seemed the logical answer. Since, under stress of war, England could not complete the essential donor organization with sufficient rapidity, it was agreed that plasma should be furnished by the United States. The New York Chapter of the American Red Cross took over recruiting of donors, while the Blood Transfusion Association supervised technical procedure.

THIS campaign lasted five months—over 15,000 persons giving approximately a pint of blood each. Such, indeed, are the unpredictable twists of circumstance! Almost before the program was well under way those serious laboratory experiments, so cautiously begun, had grown, because of great and sudden need, into a full scale, mass-production activity, serving an international cause.

Blood was taken from donors by means of a hollow needle inserted into a vein in the arm. It flowed directly into a sterile glass container and there the red and white corpuscles (which are not used in plasma transfusion) settled in a thin layer. Later, the liquid plasma was drawn off. Where a centrifuge was available, the settling process could be greatly accelerated; for, by whirling the jar on this wheel-like apparatus, the corpuscles, instead of requiring several days, were precipi-

Drawing off plasma into big bottle

tated in about half an hour, after which the plasma could immediately be removed. As soon as laboratory tests had approved individual specimens of each blood, the plasma of several donors was pooled into a kind of sanguineous cocktail which was then subjected to further tests, before final shipment abroad.

While the campaign for Britain was still in progress a new project was organized to experiment with the drying of plasma. It was reasoned that a dry product could be compressed into far smaller space than that required for liquid (an important factor in shipping), while at the same time it would be in less danger of contamination. Technique was developed rapidly and, as has now been positively established, dry plasma has the further advantage of being safe for use after as long as five years storage, with indications that it can probably be preserved indefinitely.

Soon the Army and Navy stepped in with consecutive requests for the huge quantities of "powdered plasma" now in process of being gathered. From the donor's viewpoint, present procedure is (with a few elaborations) much the same as that employed for

Removing bottles from centrifuge which whirled them at 2500 rpm

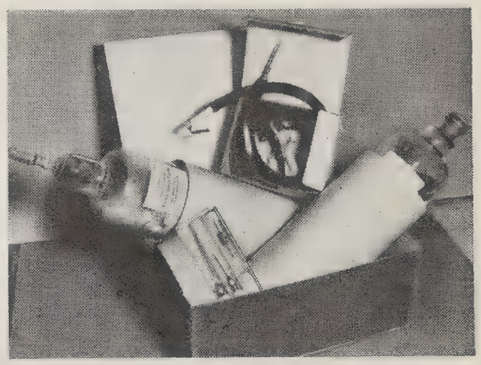
the British. The newly-taken blood is refrigerated, and within 24 hours subjected to the drying process. Tested and separated by centrifuging, the plasma is pooled and frozen in a dehydrator at a temperature of 150 degrees, Fahrenheit, below zero. Moisture is extracted by means of a vacuum pump, and the residue—a dry powder—is then portioned out and vacuum-sealed in sterile containers. Each of these, with essential needles, tubing, and a bottle containing specially distilled water, is separately packaged for shipment; the whole comprising one complete operating unit. When it is to be used, the doctor simply mixes the powdered blood with the distilled water—the result being a thickish liquid having about the consistency of condensed milk. He then adjusts needles and tubing, and proceeds with the transfusion.

As things stand at present, dried or liquid plasma does not serve in every case where transfusion is required. Still greater improvements are hoped for, as may be seen by experiments being carried on with the red corpuscles (wasted in plasma transfusion), in an effort to devise means of putting them to therapeutic use. An additional "conservation note" may be observed in the recent suggestion that corpse blood—from fatal accidents—be gathered for storage against emergencies. To the gratification of the more squeamish, however, most medical leaders do not appear to favor this practice, holding that it would necessitate such exhaustive tests and precautionary measures as to nullify its possible value. More likely of adoption is the proposal to accumulate plasma in connection with the Civilian Defense Program—an idea which would seem well founded, since military supplies could scarcely be released for civilian needs.

To insure an adequate reserve of plasma for the duration, the Red Cross "Blood Donor Service" is already taking "blood gifts" in an ever-expanding number of cities throughout the country. Several chapters also operate "Mobile Units" which daily visit small communities within a radius of 100 miles of the permanent headquarters, enabling volunteers in these localities to participate. Any man or woman in average health between the ages of 21 and 60 is acceptable and there are many who make donations periodically, present regulations specifying that these be spaced at least eight weeks apart, not more than five being permitted within one year. Donors are asked to avoid eating for four hours before giving their transfusions, in order to prevent absorption by the plasma of food substances to which the recipient may be alergic.

As you chat informally with doctors and nurses at Donor Service Headquarters, you hear of persons who travel considerable distances in order to give their donations. You hear also of soldiers and sailors on leave, coming in to give their little "extra bit." And of course you hear the irrelevant but classic story of the maiden lady, who, some years ago required a transfusion, but, upon learning that only a male donor was available, declined the treatment—or at least so says the legend—insisting that she would not permit herself to be contaminated by masculine blood.

Dr. Landsteiner, who solved the mystery of the blood groups, back in that other Vienna—the Vienna that was, at the turn of the century—now



Bottle of plasma, bottle of distilled water, for the Navy and Army

pursues his serological investigations at the Rockefeller Institute for Medical Research. Talk with him in his laboratory and you are profoundly impressed with his patience, his self-effacing modesty. In unstudied sincerity, he minimizes the significance of his discoveries, pointing out that his investigations were so basic that it seems strange some other researcher had not embarked upon them long before. He tells you, too, that with the increasing acceptance of plasma, which need not be typed before transfusion, the usefulness of his findings will rapidly diminish. And as you listen with respectful interest, you fully appreciate the conscientiousness of these assertions. But—you do not accept them.

You do not accept them when you ponder the extent of serological and other scientific progress traceable either directly or indirectly to his ground-breaking work.

You do not accept them when you remember the 1500 transfusions administered in London during that sinister, bomb-bedeviled September, 1940.

Nor do you accept them when you contemplate the nearly one and a quarter million units of dried blood with which our own Army and Navy Medical Staffs hope to save innumerable lives in the yet-to-be-fought battles of the present conflict.

No, in spite of Karl Landsteiner's claim that the importance of his discoveries is already waning, you soon realize with increasing clarity that, as a result of his work, America is daily growing more transfusion-con-

scious, and is turning out in ever larger numbers to do its part toward alleviating the ravages of the dictators on this poor, war-scourged planet.

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BLEEDERS

New Hope for Those Who Bleed Excessively

NEW protection for hemophiliacs against danger of excessive bleeding, and effective help for physicians, surgeons, and dentists in staunching the flow of blood from small wounds is provided by a new, powerful agent for clotting blood recently announced by Lederle Laboratories, Inc.

The new material, called clotting globulin, is the natural clotting constituent of blood separated in highly concentrated form from clear blood plasma (blood from which the corpuscles have previously been removed).

Many persons bleed excessively from minor wounds because their blood contains too little of the clotting principle (prothrombin). This condition may be inherited and permanent (hemophilia), or it may be temporary, the result of the ravages of disease or other causes. When it exists, even slight wounds may become serious through excessive loss of blood. No satisfactory method has been known before to control bleeding in persons thus afflicted and even pulling their teeth has involved serious hazard to their lives. Previous treatments employed have included transfusions of normal blood, applications of snake venom (fer de lance), and the use of various substances having hemostatic action.

The new clotting globulin supplies the constituent in which the blood of "bleeders" is deficient and places in the hands of the medical and dental professions an effective means for stopping the flow of blood from minor wounds in a few seconds. The procedure is simple. A few drops of a solution of clotting globulin are applied to the surface of the wound either by spraying or on sterile absorbent cotton or gauze, followed by gentle pressure. By making up the deficiency of the patient's blood, this treatment causes it to clot in the capillary blood vessels within a few seconds.

The method is not effective against bleeding from veins or arteries—this requires surgical treatment—but it has been shown by clinical tests at Boston City Hospital and elsewhere to stop bleeding from minor wounds quickly. Excessive bleeding following the extraction of teeth and the oozing of blood from surgical incisions are stopped within a few seconds by the proper application of clotting globulin.

Clotting globulin possesses true thrombic activity in coagulating the fibrinogen of the blood. It acts by supplementing the prothrombin naturally present. Clotting globulin can be used only locally and under the supervision of a doctor or dentist. Its effect is solely to coagulate the blood at the point of application, and it does not remove danger of excessive bleeding from other wounds.

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ANISEIKONIA—A special study of 400 aviation cadets showed that two out of every 25 men had aniseikonia—a condition which produces unequal images in the two eyes—to the extent of 0.5 percent, or more, according to the Better Vision Institute. Differences in visual images, however, in no case were more than 1 percent.

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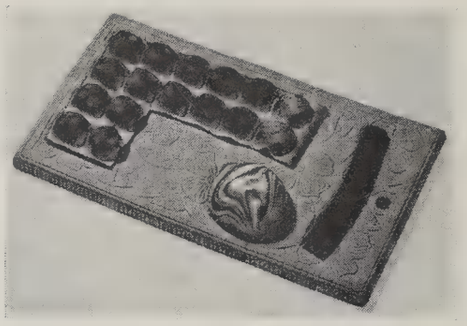
TIRED FEET

The Home-Made Foot Pad May Help Rest Them

STANDING at work is the most important single factor in the production of industrial fatigue. Human feet are much better designed for walking than for standing; in standing on a plane



Foot rester

surface, the body weight is constantly borne by the same groups of foot muscles and ligaments. These groups gradually become fatigued and begin to protest.

In an effort to prevent this torment, Dr. Robert Sacks, New York osteopath, has used weight-shifting footpads made by cementing various rubber objects to sponge rubber (dime-store) kneeling pads. "In standing on these I frequently change the position of my feet," says Dr. Sacks. "With each shift of position the feet find a differently tilted plane. In this way the weight is constantly shifted from one group of muscles and ligaments to another; and so no group is subjected to undue strain. This simulates the positions of the feet in walking over turf."

BEAT THE HEAT

Vitamin C Staves Off Heat Prostration

TWO tablets a day are keeping heat-prostration away for many war production workers this summer. The "beat-the-heat" pills contain Vitamin C, which physicians of the Du Pont Company's Medical Division have found effective in protecting the human system against heat cramps and prostration, even in places where the temperature rises above 100 degrees and the humidity is oppressively high.

Dr. John H. Foulger, director of Du Pont's Haskell Laboratory of Industrial Toxicology, at Wilmington, Delaware, believes the preventive might well be employed in many other plants, including steel mills, foundries and shipyards, where high temperatures are encountered. It should also prove useful in the engine rooms of naval and transport ships and among troops in the tropics.

The procedure is to give twice each day a tablet consisting of 50 milligrams of Vitamin C and 250 international units of B-1, plus other B vitamins. B-1 is also believed to play a part in protecting against heat attacks but its action, in this particular situation, is not yet so well understood as is that of Vitamin C.

This measure is directed chiefly against the heat cramps and heat exhaustion, or heat prostration, and not against sunstroke or thermic fever, in which there is no sweating and the individual's temperature rises. The two former conditions are by far the more prevalent in industry, however, and prevention of them would save many hours and days of lost time in the production race against the nation's enemies.

An important part of the picture is that Vitamin C is drained from the body in perspiration, just as salt is. Salt pill dispensers have in recent years been installed alongside nearly every factory drinking fountain, so that workers may replace the salt they have sweated out. This has helped ward off heat cramps and heat exhaustion, but many cases have still occurred. Therefore Vitamin C, which prevents other aspects of the condition, should also be given. In other words, salt alone does not appear to be nearly as effective in preventing heat attacks as does a proper combination of vitamins and salt.

Little Pictures—Big Savings

Microfilm Has Joined the War Effort, Lending its Advantages to Civilian and Military Uses Alike

LUCILE N. McMAHON

MICROFILM joined the war effort well qualified for a vital task. Its unique services in peacetime to librarians and businessmen are proving of great value to the war industries. Among the more important and timely benefits are: Release and saving of valuable and much-needed space; protection of irreplaceable records against loss from sabotage, bombing, fire or theft; increased availability of all records. Microfilming can serve the interests of every company concerned about any or all of these problems.

This phase of photography is not new; in fact, the process of making tiny reproductions of drawings and documents on film originated during another war. In 1870, Paris was beseiged by the Prussians and cut off from communication with the outside world except by balloons carrying outgoing messages and carrier pigeons for the return mail. These slim threads of contact were the only hope of organizing resistance in the French provinces and of possibly securing aid from other countries. Balloon flights were infrequent, and the weight of mail, particularly incoming, was very small.

Then an idea came to Dagron, a photographer who had been making his living selling opera glasses having a miniature photograph of a Parisian scene on the lens. He printed the messages for the pigeon post on large sheets and photographically reduced them in size until film representing 3500 folio sheets could be carried on the leg of one bird. A strip of his original film is now in the Library of Congress. That was the first recorded use of microfilm for documentary reproduction.

Today, the same principle is used to lighten the load of mail shipments overseas, is being used for soldiers' letters to the folks back home, and our Army and Navy have other uses for microfilm that come within the category of military secrets. But what is microfilm's part in civilian life during war?

Suppose a bomb or a saboteur's torch destroyed the central office of the telephone company—or the light, gas, or water company—and its records, maps, and charts were lost. Civilian life and industrial production alike would be at a standstill until these vital services could be restored; and that would require a long time if there were no engineering drawings from which to work.

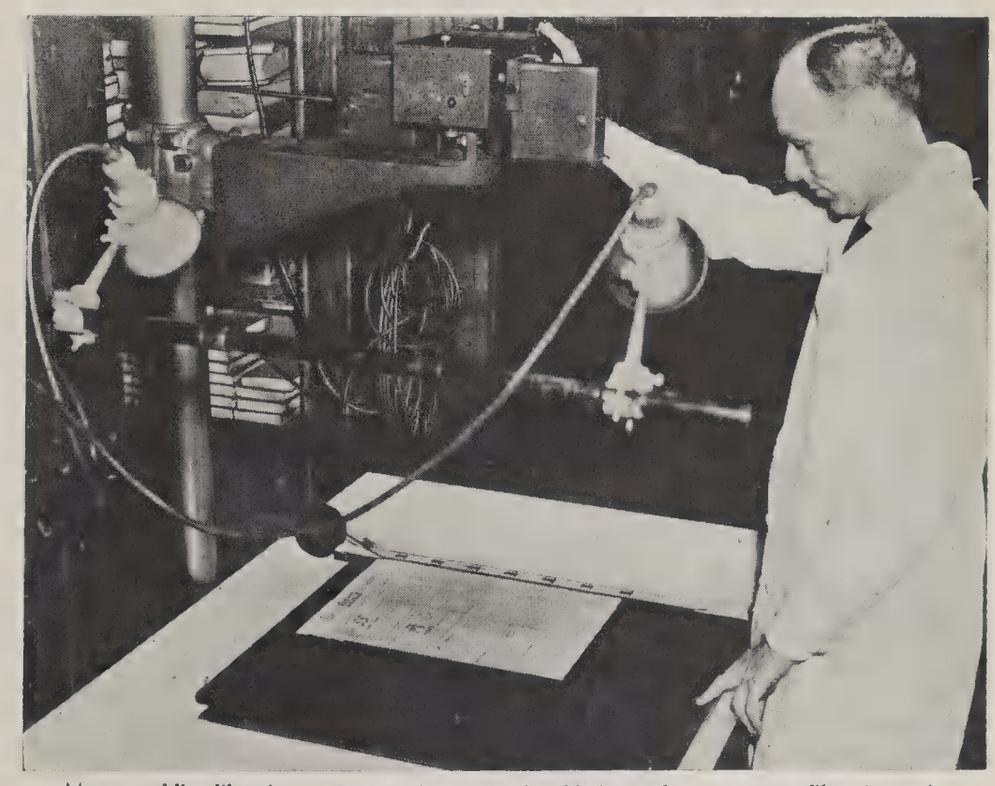
A logical precaution is to make duplicate copies of the irreplaceable cable records, maps, charts, and blueprints, and to keep them in bombproof shelters or at inland points where the risk is less. But facsimiles of all such documents would represent a large bulk, and would involve heavy expenses for transportation and safe storage. Even then they would not be readily accessible.

Microfilm best meets the situation. Condensed into roughly 3 percent of the original space, microfilm prints can be sent by air mail to several places for additional safety, if desired. Because facilities for microphotography are readily available and inexpensive, the records can be refilmed periodically and thus kept up to date. Some New England utility companies are now doing this every six months.

The service which microfilm renders to the utilities also meets the needs of concerns turning out war materials. The air-raid menace has caused some talk of moving industrial plants in coastal regions further inland, but that can be done only to a limited degree. For the most part we shall have to depend on anti-aircraft defenses, camouflage, and strict precautions against sabotage to protect our all-essential production. Yet, the most vulnerable spot of all—the drafting room, where design drawings are made, kept, and used—can be further safeguarded.

If fire or bomb should destroy a plant now producing, say, airplane detectors, weeks of valuable time could be saved in reconstructing it if duplicates of the engineering designs were available—details of each complicated and specialized piece of machinery. Drawings in work covering new plant construction, enlargement, and conversion are too valuable at this stage of the race for production to risk their loss by fire, theft, sabotage, or accident.

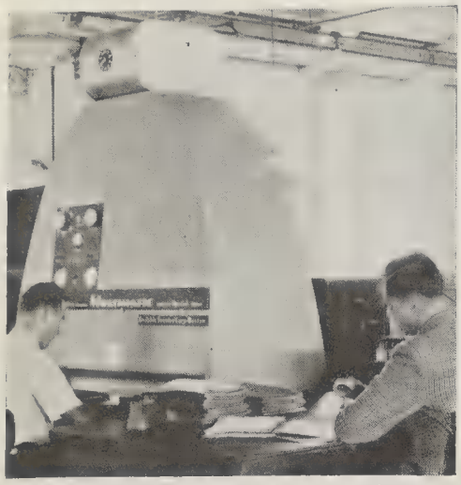
PUTTING the drawings on microfilm makes it possible to guard them like crown jewels. The Du Pont Company is among those which have taken this precaution. Another firm producing machine tools had some 400,000 charts, occupying 1500 square feet of space, with the number mounting daily. Reduced to microfilm the whole lot could be put into two drawers of a regular letter file, leaving 97 percent of storage space free for drafting-room ex-



Many public libraries are resorting to microfilming of newspaper files in order to conserve storage space and overcome problems of paper deterioration

pansion. About 9000 drawings, six by eight inches, were duplicated on a reel of film the manager could slip into his pocket or, more desirably, into a small safe-deposit box.

Apart from safety, economy of space itself is a contribution to the war effort, at a time when materials and labor are at a premium. Office space in



Camera that can reproduce on microfilm drawings 20 feet or more long

Washington is so scarce that many employees work in hallways or converted bathrooms. It is estimated that 25 percent of the total space in the Federal buildings is used for storing files. If records in inactive files were microfilmed, with a saving of 95 to 98 percent of this space, not so much new building construction would be necessary. To this end, a recently-passed law permits permanent public documents to be thrown away if microfilm copies are available.

The importance of microphotography is recognized by the draft-deferred status granted to employees in this field, which was one of the first explored by members of the National Defense Research Committee. Cameras, readers, and film were already on the market. Librarians may take much of the credit for that. About ten years ago, they had found that microfilm was the solution to the vexing problem of what to do with those dusty, crumbling, unwieldy files of old newspapers. As historical records they were too valuable to be thrown away, so their vast bulk was reduced to compact little reels of film that could be kept in drawers instead of storage rooms—that could be consulted and projected to legible size instantly when needed.

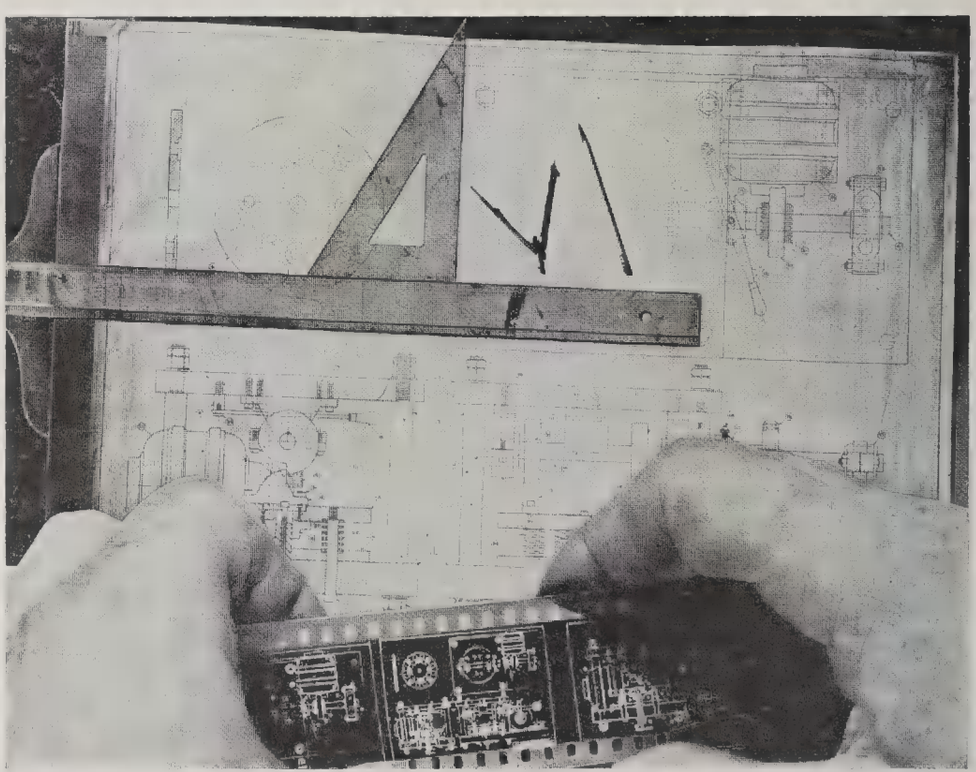
Then the practice extended to rare books and manuscripts, in order to make their contents available to readers without wear and tear on the original. Today, the Library of Congress can furnish a microfilm copy, or a positive enlargement, of any part of its nearly ten million volumes. Newspapers from 37 different lands, war or no war, are available through Harvard's microfilm subscription service for other libraries. Brown University has undertaken to film the ancient archives in Latin America. All English books in the British Museum, written before 1500, have been put on microfilm by a project sponsored by American universities. Microphotography has reached the stage where it now has its own magazine, *The Journal of Documentary Reproduction*. More and more libraries have secured equipment, and the development of both apparatus and film has been rapid.

Microfilms, in protecting cans, are stored in a safe-deposit box

CULMINATING years of research on photographic emulsions, Du Pont chemists have perfected a new type of microfilm which is being introduced to photographers as Du Pont Safety Microcopy. It is described as "an ultra-fine grain, panchromatic, negative film with a high inherent contrast and outstanding resolving power." In case you're not a camera fan, the resolving power refers to its ability to register fine detail. Safety Microcopy permits documents to be reduced to one nine-hundredth the original area and later reproduced to full size without significant loss of legibility. High contrast is particularly important in photographing line drawings and printed matter. By varying the type of developer used, the contrast of the film can be reduced as may be necessary to reproduce screen halftone prints, paintings, and X-ray radiographs. A special treatment of the film emulsion produces a tough surface that minimizes scratches and abrasions, and greatly prolongs the life of films subjected to constant use.

You could even put Du Pont Microcopy in your candid camera and microfilm a few of those old love letters in your attic. But if the microfilming job is a big one, you had better employ a company that specializes in such service. For a moderate fee it will not only guarantee the technical part of filming and processing but will also collate and check the material and recheck the film after completion to make sure that it exactly reproduces all of the original material.

The president of one such firm, in discussing microphotography, has this to say: "The hundreds of industrial and business firms which are turning to microfilm for their valuable records now have safety uppermost in their thoughts. But they almost always find



One tiny frame of microfilm—the space between the fingers above—accurately reproduces a complete engineering drawing, such as the one shown in the background

How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

▪ ▪ ▪

What does the lady in *your* life think of *your* success? Get more of the Alexander Hamilton Institute's story in the famous little book, "Forging Ahead in Business." Tells how the Institute's timely training is helping thousands of men to do a better business job in these wartime days. Just clip and mail the coupon—today!

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other important advantages which are impossible to get with any other form of duplication. I mean economy of space, availability, convenience, permanence, and, when any considerable number of pages is involved, actual cost economy. Banks and insurance companies have already made wide use of microfilm to protect their customers' interests. Department stores are finding that microfilming all invoices is a safeguard which more than pays for itself. Inactive but valuable files of all sorts are being consigned to microfilm. Business and industry were discovering these advantages without the added urge to safety which war has brought. War conditions, by causing microfilm to be tried by more people, have only hastened its widespread adoption."

Industry, business, and government are not the only prospective users of microfilm. For instance, hospitals are required by law to keep records covering each patient admitted—ordinarily fifteen to twenty pages each. A large institution like Cook County Hospital, in Chicago, averages 50,000 admissions a year. Many a superintendent wonders how soon the records will crowd out the patients! Microfilm reproduction is the answer for X-rays, charts, laboratory tests, and all the rest. Not only does it save space, but often serves medical research as well. For one medical center may have few or no case records of a rare disease for study, but if the records of several hospitals are assembled on microfilm, the combined information may have more than statistical significance.

Music students at the New England Conservatory now study microfilmed scores of symphonies and operas. The Frick Museum in New York has put on microfilm its leading paintings for the benefit of art schools throughout the country. These are but arrows pointing to the vast possibilities of microfilm in education, apart from scholarship.

Some day the curator of the Hall of Fame may ask Mr. Gutenberg, inventor of the printing-press, to move over and make room for a French photographer named Dagron!

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GLASS STOVES

Loom as Possibilities as Result of Research

KITCHEN stoves made of glass have now moved within the realm of post-war practical possibilities as the result of intensified research into applications of new types of flat glass to release critical materials for the war program.

A thought-provoking step was taken when the idea of a glass observation port in a kitchen range door, introduced prior to the war as an innovation to reduce temperature loss and jars resulting from repeated openings of the door to check baking progress, was extended to include an all-glass door.

Intended to increase such vision efficiency, and temperature control, the

You can watch the food cook

all-glass door suddenly blossomed as an important idea in metal conservation.

War-stimulated design then expanded the idea to make a vision-top, utilizing the same heat-strengthened Tuf-flex plate glass as was used in the door to make vision possible from above.

A further metal-conservation move came with the idea of using a colored opaque structural flat glass—the very same glass that has become popular as a facing for storefronts, corridors, kitchen and bathroom walls, and other applications—to line the inner walls of the oven, to save more metal. It was then discovered that such a glass-lined oven actually retained heat better and utilized it more efficiently and evenly than metal-lined ovens.

Happy about the whole thing, the glass technicians still weren't satisfied. They used still another type of glass, a heat-strengthened plate glass in translucent color, for the inside back wall of the oven, with lighting back of it, thereby achieving shadowless illumination.

Finally, in their hope to conserve still more metal for the battle fronts, they designed an instrument panel of the translucent, heat strengthened glass (the glass men call it "vitrolux") and thus was born still another use for glass in and on a kitchen range.

Can they go further? The glass boys just grin at that query. Will they go further? Well, not right now. The glass technicians point out that their glass stove design at this time is a sort of after-hours form of relaxation when they are not ears-deep in designs for the job in their and everybody's lap—the job of winning the war.

Still, what they have accomplished, even if it is an after-hour form of relaxation, makes for some fascinating visions of what can be expected in the post-war era — not only the possibility of glass stoves but glass most-anythings.

TRACTOR LUGS

Made of Wood to Conserve Rubber

A PARTIAL solution to the tire problem has been worked out for Kansas wheat farmers in the rationing office of the OPA. When wheat was ripe for the harvest many of the farmers found they could not get tires for tractors and combines, so the OPA office in Wichita had a trial set of wooden lugs built of 3 by 5 inch white oak and attached to the rims of tractor wheels with 3/8 to 5/8 inch iron rods held in place by turnbuckles. The lugs are applied at an angle of 35 to 40 degrees across the rim, approximately 15 to each wheel and are 18 to 24 inches in length, depending on the width of the tractor rim.

These substitutes for rubber tires gave the required traction. Cost of the make-shift equipment runs from $35 to $50 a pair. While it was only anticipated that the wooden lugs would insure the use of tractors through the present wheat harvest, if the wood is creosoted or dipped in oil they will, in many instances, serve the farmers next year.

RAYON IN TIRES

For Military Use, Conserves Rubber

AMERICA'S army is rolling to war on rubber—and rayon. Rubber has commanded the public's attention, because of the acute nation-wide shortage. But a special type of rayon, an all-American development using only American raw materials, has been conserving important tonnages of rubber.

Tough sinews of this high-tenacity rayon lie beneath the precious rubber skin of military tires—for bombers, combat cars, or transport trucks. Possessing greater strength than any other tire fabric beyond experimental stages, and retaining its great strength under the high heat of heavy-duty driving, this rayon permits tires to have thinner but stronger walls and adds thousands of miles to their life.

The high-strength yarn, developed by Du Pont chemists and marketed

under the trade-mark "Cordura," must take an almost unbelievable amount of punishment. The huge tires of the heavy bomber are required to stand up under the jolt of tons of metal landing at high speed, without a blowout. The combat car is driven over the roughest terrain, a severe test in itself, but the Army demands as well that the combat car tire have sufficient structural strength so that, if punctured, it can run flat for many miles so the car can complete its mission or reach a place of safety.

Invention of high-tenacity rayon was the culmination of ten years of research effort to improve the strength of viscose process rayon. It was a high spot, too, in the history of viscose rayon itself, which is observing its fiftieth anniversary this year.

Ordinary rayon is usually made from the cellulose of purified wood pulp. "Cordura" high-tenacity rayon is made from the cellulose of cotton linters, the short fibers remaining on the cotton seed after the longer, spinnable fibers have been removed in the ginning. The difference in the raw material is not so important, however, as are certain steps in the process, particularly the stretching of the filament immediately after it is formed.

As in the case of the so-called cold-drawing of steel or nylon, this stretching causes the molecules of the material to line up parallel to one another so that powerful intermolecular forces come into play, which lead to greater strength by preventing the molecules from slipping apart under tension. The final product of careful chemical and physical control, and of stretching, is a filament having a tensile strength of 70,000 pounds per square inch. In fact, the rayon cord tire has a skeleton as strong, for its size, as the skeleton of a skyscraper.

In building a tire, several dozen cords are unwound simultaneously from a rack of spools (known as a creel) and brought out to lie parallel with one another in a broad ribbon. There are no cross-threads in most modern tire fabrics. They are not woven materials, although the cords of successive plies run in different directions, to give strength. The ribbon of cords passes through a dip of liquid latex, formaldehyde, and resorcinol, which insures a firm union of the cords and the rubber. A layer of semi-soft plasticized rubber is then applied to each side of the ribbon of cords, and is pressed firmly into the spaces between the individual cords. Other plies are similarly built up and assembled, covered with the tread, and the whole vulcanized in the tire mold.

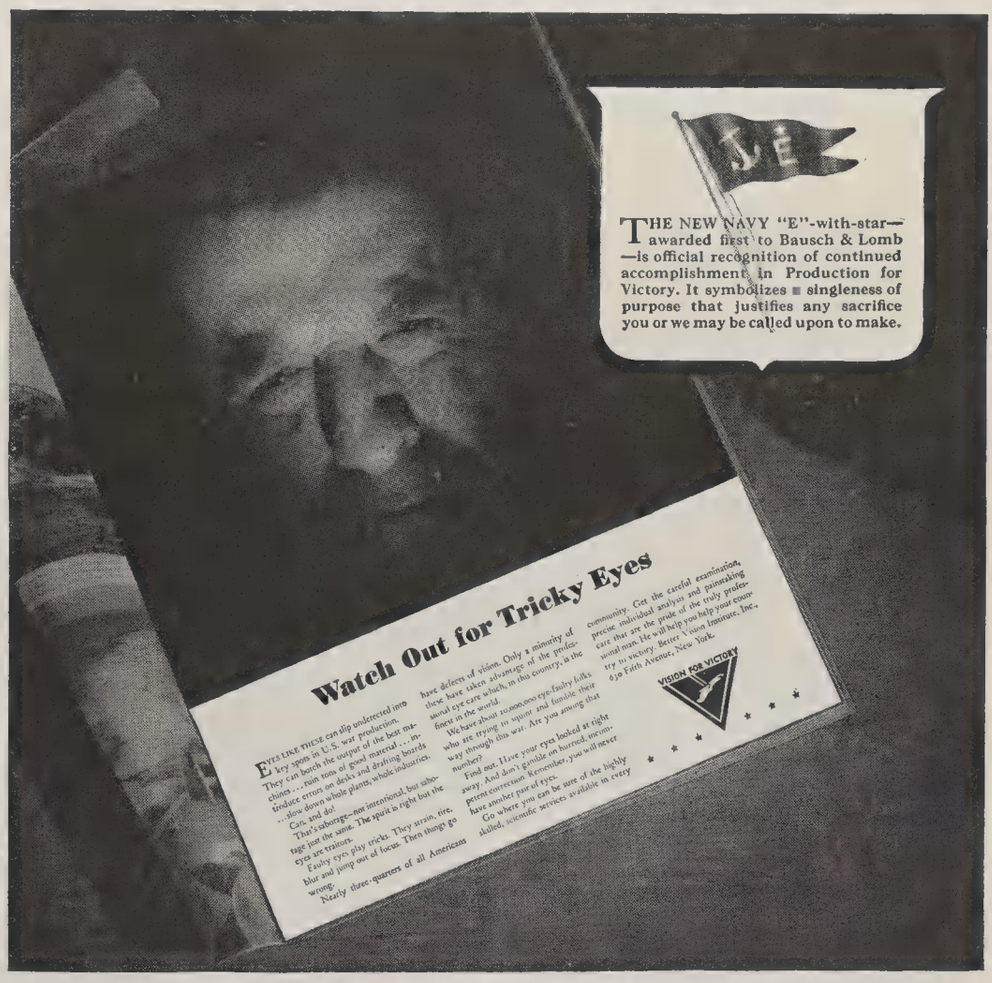
Chief advantage of "Cordura" high-tenacity rayon is that heat does not sap its strength as it does the strength of cotton cords. Consequently it can be used more sparingly in building a tire. Also, the tires are more resistant to blowouts when hot. The walls are very strong but thin. Thin walls dissipate heat and keep the tire cooler. Rayon cord tires average to run 15 percent cooler than other tires. Because the rayon cord tire carcass lasts longer, it can economically take a thicker tread and can also be re-treaded more times.

The lighter-weight tire made possible by rayon cords is of particular importance in aviation, where the tire is needed only for taking off and landing and is simply extra weight during the flight. Obviously the saving of tire weight, to give more maneuverability and sky mileage or to make room for more guns and bombs, is of tremendous importance in military planes.

EXCESS MOISTURE

Absorbed from Air in Damp Rooms

BASEMENT workshops, photo darkrooms, closets, vaults, laundry rooms, can be kept free of damp and musty air with Dri-Air powder, a chemical


THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes ■ singleness of purpose that justifies any sacrifice you or we may be called upon to make.
Watch Out for Tricky Eyes
EYES LIKE THESE can slip undetected into
VISION FOR VICTORY

Vision for Victory

THE future of the world today depends on American industry's capacity to produce the implements of war. The Soldiers of Industrial Production must be welded into history's most efficient fighting organization before the spectre of aggression can be dispelled.

Because most skills depend on efficient functioning of the eyes, and because nearly one-third of the people of the nation still have uncorrected faulty vision, a valuable public service is performed by calling attention of American workmen to the importance of proper care of their eyes.

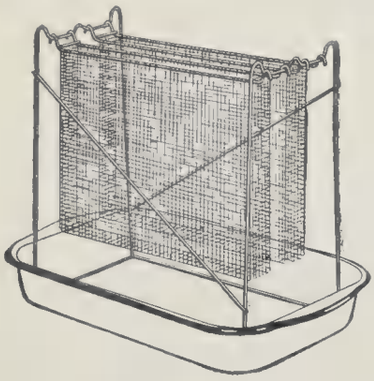
Taking as its theme "Vision for Victory," an advertising campaign (one insertion of which is reproduced above) is now appearing in an extensive schedule of nationally-circulated magazines. The program is sponsored by the Better Vision Institute, a non-profit service association, supported by the manufacturing, distributing and professional branches of ophthalmic science.

We also hasten Victory who make minds keener and hands surer through the improvement of human vision.

BAUSCH & LOMB
OPTICAL COMPANY ▪ ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

which is exposed to the air at all angles so as to do a maximum air-drying job. After the powder has absorbed all excess moisture in air it remains ready to remove dampness as fast as it forms. The chemical is placed in a special container made up of a one-piece, triple "V" shaped basket, that holds ten pounds of powder. As



It makes the air drier

moisture is drawn from air, the drippings are deposited in a metal pan below the basket.

One container is recommended for each 800 to 1000 cubic feet of space. Even the chemical drippings are valuable and should be saved for melting ice on slippery sidewalks and in eaves and waterpipes; it is also useful for settling dust in gravel driveways and for killing weeds.

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SHIP POWER—Over 400,000 Diesel horsepower, including propulsion and auxiliary engines, were installed in 391 vessels added to the United States Merchant Marine in one 12-month period.

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ELECTRONIC SEPARATOR

Points Toward Use of Low-Grade Ores

ELECTRONICS research engineers recently demonstrated an "electrical spray" that "washes" war-needed metals from low-grade ores, and which may prove to be a valuable aid in easing America's tin shortage. In laboratory experiments the device, a new electrical ore separator, has successfully refined ores of such metals as tin, iron, and gold, most promising results having been attained with low-grade ore samples from a recently developed tin deposit in a southern state. By spraying electrical charges on this ore, which contained only 1.5 percent tin, the new Westinghouse device separated the metal from rock and sand, concentrating it into an ore containing approximately 70 percent tin—suitable for smelting.

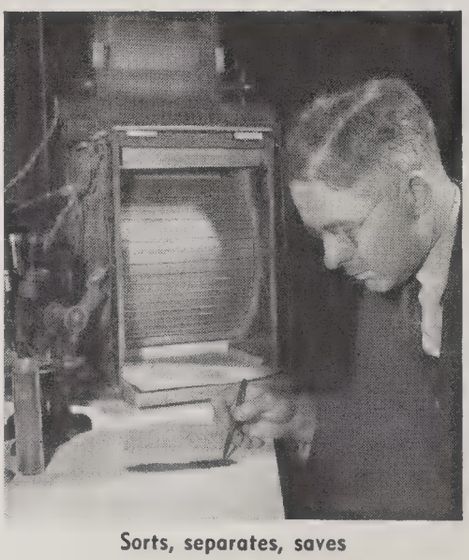
As the foot-wide metal drum of the laboratory model of the separator turned with a surface speed of 12 miles an hour, in the demonstration, it sorted in one minute the 10,000,000 particles making up ten pounds of ore. The particles were deposited in two neat piles. One of these piles contained rock and sand and a small percentage of tin; the other, nearly all the tin, mixed with a small amount of rock and sand.

The ore had been ground to the fineness of sand, dried, and then poured into a trough at the top of the two-foot-tall experimental separator. As the particles of sand, rock, and tin trickled through the bottom of the trough, they fell onto the rotating metal drum, where they received high voltage electrical charges from a series of fine wires a short distance from the drum's surface. Since the tin particles are good conductors of electricity, the electrical charges seep through them and into the metal drum. The tin particles thus lose their charges before the drum has made more than one half turn, and fall off the drum. But the poorer conducting sand and rock particles retain their charges and cling to the drum until pulled off—during the second half revolution—be a series of oppositely charged wires.

Though it is necessary to dry the ore before it can be separated by an electrical spray, the new device may prove to be more efficient than present ore concentrating methods which do not require drying.

Other possibilities for the electrostatic separator arise, since it can sort mixtures of any two materials provided one component is a conductor of electricity and the other such a poor conductor that it is in effect an insulator. In addition to experiments with low-grade tin and other strategic ores, the machine may be used to purify foods.

In foods, the good conductors are usually the ones which contain the most water, and the poor conductors those which contain oils and little water. In trying to separate shells from the meats of nuts, for example, it was thought at first that the dry shells would be poorer conductors than the moist meats. It was soon discovered, however, that because the meats got their moistness from oils, they were little better as conductors than the shells.



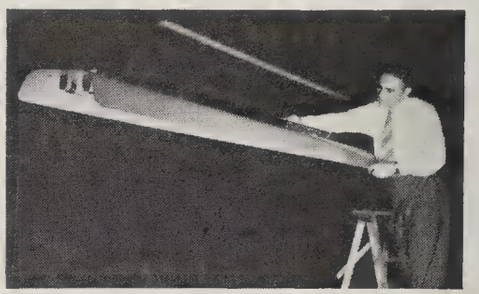
Sorts, separates, saves

The Westinghouse research men are now planning tests to separate foreign materials from grains and stems from raisins with the electronic unit.

FLUORESCENT FIXTURE

Steps Up Lighting Efficiency

DEVELOPMENT of a new circuit for fluorescent lighting fixtures and a specially designed ballast control unit—a system which makes possible a saving of millions of pounds of critical metals and also improves lighting efficiency—was announced recently by the



Conserves metals, improves lighting

General Electric lamp department at Nela Park.

The new fluorescent circuit permits the use of only one ballast—or control unit—with four 100-watt Mazda fluorescent lamps in place of the present 100-watt fluorescent fixtures which require two ballasts for four lamps. The two lamps on each phase of the new circuit start in sequence and operate in series. Thus, one ballast does the work of two, effecting important economies in any fluorescent installation where the new circuit can be used. Although it is designed for use only with 100-watt fluorescent lamps and on 254, 265, and 277 volt circuits, many of the new war industry plants have these voltages available and other plants now being converted to war work can be changed over to take advantage of this circuit.

While the increase in efficiency in producing fluorescent lighting to speed wartime production cannot be overlooked, the saving of critical materials by this new cicuit is of major interest at present. For instance, in one large airplane plant where fixtures using the new hook-up are under consideration and in which more than 35,000 100-watt fluorescent lamps will be installed, engineers estimate that 23,275 pounds of copper, 80,960 pounds of iron and steel,

and 3250 pounds of aluminum will be saved. The overall saving in the weight of the ballast equipment would total about 132,000 pounds and a total of 303 kilowatts of current would be released for other war uses.

ERROR-PROOF

Radio-Telegraph Printer Put Into Service

ALL possibility of error from defective signals in radio-telegraph transmission is eliminated by a new error-proof radio printer put into operation in the international communications field recently on the direct radio circuit of R.C.A. Communications, Inc., between New York and Buenos Aires. Product of RCA Laboratories, the new printer works with brain-like facility. It automatically rejects false signals and prints an asterisk in place of an incorrect letter.

Present secrecy restrictions necessitated by the war prevent a full description of the printer. RCA Communications officials say that it could be revealed, however, that the device operates with a special code so constructed that a defective character is immediately recognized as such by the printer.

With ordinary telegraph printers as used on the radio, errors may be caused by spurious signals, RCA engineers explain, and this was one of the primary motives that led them to develop the new machine. The appearance of an extraneous signal, or the absence of part of the correct one, will cause printing of an incorrect letter on the ordinary instrument. Unless the error is obvious, it may go undetected.

CAMOUFLAGE

Art Competes With Photography's Revealing Eye

CAMOUFLAGE of military and industrial installations, which has flourished since Shakespeare's Birnam Wood moved on Dunsinane in the famous sneak-punch attack on Macbeth, has assumed a new and widespread importance as World War II progresses.

Currently referred to as "protective concealment," the art has developed into a contest of wits between the camouflage experts and a new type of military technician known as a photo-interpreter whose duty it is to view aerial photographs of suspected camouflage and endeavor to pick it to bits, a study by the Aeronautical Chamber of Commerce of America reveals.

The essential objective of camouflage is, of course, to puzzle the bombardier, delaying his recognition of his target for the split second that may determine the success or failure of his mission.

Thousands of dollars are daily being spent as America seeks to confuse potential enemy sky bombers and protect industrial plants, factory buildings, railroad yards, airfields, communication routes, conspicuous landmarks, and transportation systems. It is the aerial camera, such as those developed by the Fairchild Aviation Corporation, which has put the old types of camouflage on the spot and rendered the task considerably more complicated—and costly—than was the case during World War I.

While the camouflage technicians aren't revealing many details about newly-devised concealment measures, they will nevertheless talk about some of the tricks of their trade. They are using dummy or decoy installations, false highways, considerable smoke or fog-generating equipment, "disruptive painting," and structures built of salvaged lumber, chicken wire, and cheap textiles, artificial tree planting and foliage hung from nets or wire guys. Flood lighting often helps eliminate artificial shadows which do not keep step with the sun's progress. A fixed shadow is a dead give-away to the photo-interpreter who may be studying an aerial photograph of the decoy installations.

Airport installations are often toned down by darkening roofs, runways and taxiways with paint, cinders, or some other medium which will make them photograph the same tone as the surrounding area. Many airport facilities have now been placed under ground and there are numerous tricks for concealing grounded planes. The pilot

TOOLING FOR WAR PRODUCTION
Back of the planes and tanks and guns—back of our entire war program—stands the man behind the machine. In the toolroom of a large aeronautical plant, this craftsman at a South Bend Lathe is doing his part in defending America.
HOW TO RUN A LATHE

"HOW TO RUN A LATHE"

A practical reference book on the operation and care of metal working lathes for beginners and apprentices. Valuable as a shop text for training classes. 128 pages, 5⅛" x 8", 365 illustrations. Price 25c per copy postpaid.

The Man Behind— the Man Behind the Gun!

IN TIME OF WAR, the man behind the machine is just as important as the man behind the gun. Back of the production lines of every war industry is our first line of defense — the toolroom. Here, where precision is of the utmost importance — where tolerances are reckoned in split thousandths — you will find South Bend Lathes. Modern in design, built with extreme precision, South Bend Lathes are fast and accurate on the most exacting classes of toolroom work. Their wide range of spindle speeds permits machining with maximum cutting tool efficiency.

South Bend Lathes are made in five sizes — 9" to 16" swings, in Toolroom and Quick Change Gear types. We also manufacture Turret Lathes for production operations. Write for a catalog and the name of our nearest dealer.

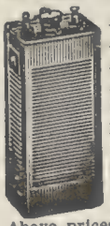
SOUTH BEND LATHE WORKS

DEPT. 509 SOUTH BEND, INDIANA

LATHE BUILDERS FOR 35 YEARS

EDISON STORAGE BATTERIES

Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.



A-4	Amp. Hrs. 150.....Ea.	$6.00
A-6	Amp. Hrs. 225.....Ea.	6.00
A-7	Amp. Hrs. 262.....Ea.	7.00
A-8	Amp. Hrs. 300.....Ea.	7.00
B-2(J-3)	Amp. Hrs. 37.....Ea.	5.50
M-8	Amp. Hrs. 11.....Ea.	2.00
L-20	Amp. Hrs. 13.....Ea.	2.50
L-40	Amp. Hrs. 25.....Pr.	4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

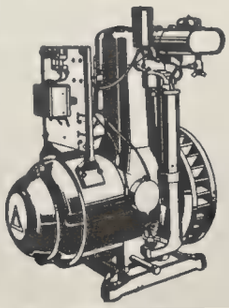
Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells..... $5.95

U. S. ARMY TELEGRAPH SOUNDERS

All brass on wood base, 20, 50, or 200 ohms. Bunnell..... $4.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.



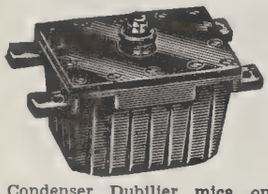
Price $225.00

Additional data on request.

TELEGRAPHIC TAPE RECORDER

Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. **Double pen permits simultaneous recording of two messages.** Pens operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms. Rebuilt & finished,

like new $47.50 Reconditioned $30.



TRANSMITTING CONDENSERS MICA

operating volts 12,500, cap. 004.
Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8,500. cap. 004 .....$7.50

NICHROME WIRE

in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound	$18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound	15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound	10.50
Schwarze 8" 100 Ohm 32 volt	10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

Build Your Own Searchlight

U. S. Army Parabolic Mirror
Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	¼ in.	$15.
20 in.	12½ in.	7/16 in.	75.
36 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand.

BAROGRAPH, FRIEZE, 7 Day Graphic, 7 Jewel movement, 28 in. to 31 in. atmos. pressure by 20th. 2 Vacuum Cylinders 3⅝ in. dia. hinge cover, glass front, mahogany case. Price $55.00

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb. Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. ARMY LIQUID COMPASS (Sperry)

Bronze jewel bearing. Leather case. 2⅝" diameter, 1¼" high $2.50

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills $27.50

24-1000 Gen. Elec. 1000 mills $50.00

12-350 volt 80 mills	$18.00
12-750 volt 200 mills	30.00
32-350 volt 80 mills	9.00
32-300 volt 60 mills	7.50

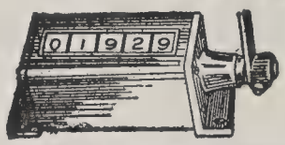
U. S. ARMY ALIDADES

Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. $1.95
45° angle adj. type, made in France

HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veedor-Root" Revolution Counter



Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ¾ inch wide $2.00

United States Govt. Fire Extinguishers

(Refillable)
Heavy Copper & Bronze

Carbon tetrachloride (pyrene liquid), pressure type, ideal for labs, trucks, boats, garages, office, etc. (10 times more pressure than hand extinguishers.) Just turn handle. No pumping necessary. Ideal for remote control with wire. (Original cost $40.00.)

1 qt. (100 lbs. pressure).....$10.50
2 qts. (200 lbs. pressure).....$16.50

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

may park his ship under trees out of sight, in foliage-covered tents, or under elaborate netting structures. Aircraft may be parked in gaps cut in hedges so that their wings will carry on the line of the hedge.

METAL CUTTER

Operates From Electric

Or Pneumatic Drill

ROTARY motion is converted to reciprocating motion in a metal cutting attachment recently developed for use with any ¼-inch pneumatic or electric

Makes clean, fast cuts

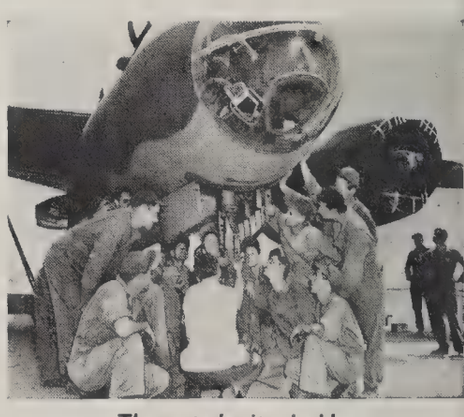
drill. Shown in use in one of our illustrations, this Royal Clipper metal cutter, manufactured by E. W. Timper & Associates, will cleanly cut sheet metals up to .040 of an inch in thickness and will cut not only straight edges but will also follow patterns and curves. For cutting out sections of panels, the cutter can be started from a ¼-inch hole. The blade removes a strip less than ⅛ of an inch in width.

AIR SCHOOL

Trains Men to Keep

Bombers Flying

A "COLLEGE OF AIRPLANE KNOWLEDGE" has been set up at the Glenn L. Martin Company plants at Baltimore —a college where soldiers study the best methods of "keeping 'em flying." The teaching staff is made up of Martin company men and includes experts



They study its insides

in hydraulic, electrical, and power installations. Every 12 days 175 graduates of the Army Air Forces Technical Training School are enrolled at the school. These men take a 34-day course designed to teach them to apply in practice to Martin B-26's what they have learned in theory during their earlier training. When they are graduated they know all there is to know about the maintenance of the Martin bomber.

Once they become thoroughly acquainted with the inner workings of the B-26, graduates of the school are assigned to bomber squadrons equipped with this particular type of plane. Wherever the squadrons go, these men who have learned the secrets of maintenance will go also. When the B-26's come home from battle, these mechanical doctors will bandage the wounds and get them back into fighting condition once again. It is one of the vital phases of aircraft warfare.

In the past, one of the most serious problems confronting the Air Forces was based on the lack of trained personnel for maintenance. As production increased, the problem became even more critical. Thousands of planes, ready to fight, are of little value unless there is available an adequate supply of maintenance men thoroughly trained in the art of "keeping 'em flying." There must be several ground crew men to each flight crew member.

In adopting this program, the Army Air Forces have moved swiftly. Where could they find better teachers than at the plant where the ships are made? The men who "get 'em flying" also know best how to "keep 'em flying."

• • •

CROSSING DEATHS—Fatalities resulting from highway-railroad grade crossing accidents in the first four months of 1942 totaled 708, an increase of 78 fatalities compared with the corresponding period of 1941, the Bureau of Statistics of the Interstate Commerce Commission points out.

• • •

SEA 'PHONE

By Underwater Cable, Seen As Possible

A TRANSOCEANIC telephone cable, carrying 12 conversations at once and utilizing delicate vacuum-tube amplifying apparatus that would function on the ocean bottom, is described as feasible by Dr. Oliver E. Buckley, president of Bell Telephone Laboratories.

Such a cable, employing the "carrier" principle, would be much like the coaxial cables now in use between New York and Philadelphia and elsewhere in this country. Vacuum-tube repeaters would be an integral part of the underwater cable. They would be placed at 40-mile intervals, supplied with current by lines within the cable, and would be expected to function for as long as 20 years without attention.

Actual construction of such a cable, Dr. Buckley said, is well in the future because many construction details must be tried out under field operating conditions. He emphasized, however, the need for another type of transoceanic communication system to be used in combination with the radiotelephone channels which are now becoming crowded. It was the strain in the last pre-war years on these radiotelephone facilities that led telephone scientists to resume experiments carried on in the 1920's. A short section of such a cable built and tested during the earlier experiments proved technically satisfactory, but the project was abandoned because of the business depression and advances in shortwave radio.

"From purely physical considerations," Dr. Buckley states, "it now appears feasible to provide all of the facilities for telephone connection between all points on the earth that its inhabitants are likely soon to require."

Wollensak means Good Lenses
For over 43 years sport-loving Americans have turned to Wollensak for high quality lenses. Prism Binoculars . . . Field Glasses . . . Telescopes... Microscopes... Magnifiers—all represent Wollensak skill and precision in manufacture.
Today, winning the War comes First. Our Government's needs are being filled above all else. Which means you may have to wait for your new glass. But when you do get it, you'll find a Wollensak worth waiting for.
Wollensak
ROCHESTER, U. S. A.

Plan for
"Duration" Living
NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM
SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS
The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:
ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.
WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.
THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.
Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.
BOOKLET ON REQUEST
THE WALDORF-ASTORIA
PARK AVENUE · 49TH TO 50TH · NEW YORK

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

WHAT ARE WE FIGHTING FOR? is a booklet reproducing a series of advertisements which—clearly, concisely, and dramatically—emphasize America's part in the present-day scheme of things. *SKF Industries, Inc., Philadelphia, Pennsylvania.—Gratis.*

THE JOB IS BEING DONE is a 32-page report to the nation of present-day operations of the automotive industry. It covers completely the industry's war production progress since Pearl Harbor. Illustrated with a number of outstanding photographs. *Automotive Council for War Production, New Center Building, Detroit, Michigan.—Gratis.*

FLASHES, No. 242, is an eight-page bulletin which illustrates applications in war production of localized lighting fixtures, infra-red drying units, and coolant filters. Request this bulletin on your business letterhead.—*Fostoria Pressed Steel Corporation, 1219 Fisher Road, Fostoria, Ohio.—Gratis.*

THREE NEW ADDITIONS is a four-page leaflet describing new non-magnetic radial and pivot bearings of extreme precision and small size.—*Miniature Precision Bearings, Keene, New Hampshire.—Gratis.*

FUNDAMENTALS OF INDUCTION HEATING is the first of a series of data sheets which will completely cover the subject of the title. Sheet No. 1 presents the elementary theory of this method of heating which is finding more and more applications in various industrial processes. Request, on your business letterhead, that you be placed on the mailing list to receive these sheets as issued.—*Induction Heating Corporation, 389 Lafayette Street, New York, New York.—Gratis.*

IT'S THE LITTLE THINGS THAT COUNT! is a 12-page booklet which points out the present-day importance of conserving even the most minor office supplies, right down the line to pins and clips. It also goes into detail on the best methods for prolonging the life of items commonly used in the office. *Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.—Gratis.*

NUTRITIONAL VALUE OF CANNED HAWAIIAN PINEAPPLE JUICE is a four-page folder analyzing the content of this fruit juice. Tabulated are the vitamin and mineral contents. *Hawaiian Pineapple Company, Ltd., 215 Market Street, San Francisco, California.—Gratis.*

SENSITIVE LABORATORY AND PRODUCTION INSTRUMENTS is a four-page folder aimed directly at America's wartime industry. It describes a sensitive electronic limit bridge for precision resistance test-

ing, a highly versatile multitester for production line use, and other industrial equipment of similar nature. *Engineering Department, Radio City Products Co., Inc., 127 West 26th Street, New York, New York.—Gratis.*

"CATERPILLAR" DIESELS GO TO WAR! is an illustrated booklet which describes both combat and non-combat use of these versatile tractors. The booklet gives an excellent picture of the wide range of conditions under which they can perform. Request Form 7610. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

HELPING INDUSTRY HELP AMERICA is an illustrated booklet that presents actual case histories of how engineering service, in applying petroleum products in metal working, general lubrication, textile manufacturing, and other operations is speeding up production. The facts presented should not go unheeded by anyone concerned with industrial production. *Sun Oil Company, 1608 Walnut Street, Philadelphia, Pennsylvania.—Gratis.*

THE CARE AND CLEANING OF HANDS AND ARMS IN THE INDUSTRIAL PLANT is a 24-page booklet which concerns itself with the problems of the title and with protection of workers against industrial dermatoses. One section is devoted to the use of protective creams and another suggests a routine for on-the-job protection. *Magnus Chemical Company, Garwood, New Jersey.—Gratis. Please request this bulletin on your company letterhead.*

BLACKOUT CONTROL FOR MULTIPLE STREET LIGHTING AND HIGHWAY LIGHTING is a series of illustrated articles which gives wiring diagrams for lighting control circuits and presents a description of their application under varying conditions. *Automatic Switch Company, 39 East 11th Street, New York, New York.—Limited free distribution to engineers, contractors, and operators of war bases and large plants.*

UNIVERSAL HORIZONTAL BROACHING MACHINES is a 12-page illustrated folder which describes a complete line of these machines and presents descriptions of typical applications. These machines range in rating from three tons, 36 inch stroke, up to 25 tons, 90 inch stroke. *Colonial Broach Company, Detroit, Michigan.—Gratis.*

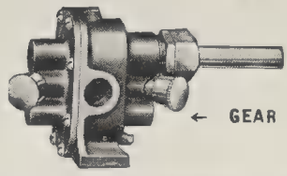
ARC WELDING INSPECTION CHART is a wall chart illustrating different types of welds under normal conditions as compared with those obtained when various factors are not normal. Also included is a table giving valuable welding information and other data of interest. *Lincoln Electric Company, Cleveland, Ohio.—Gratis to inspectors of welding and others concerned with welding.*

PROPELLAIR is a 72-page illustrated catalog describing a wide range of fans and fan applications. It contains technical data on ventilation, designed to be of assistance in the satisfactory selection of equipment for any specific purpose. Request Catalog No. 10. *Propellair, Inc., Springfield, Ohio.—Gratis to executives and engineers.*

IMMEDIATE DELIVERY

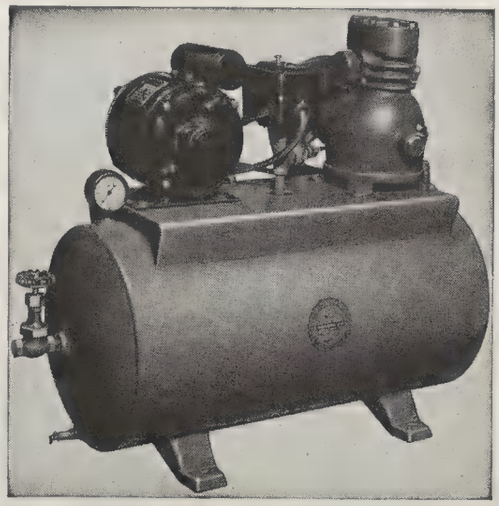
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS



		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	¼″	⅛″	$ 6.50	$25.00
No. ¾	"	¾″	½″	13.50	32.00
No. 9	"	1¼″	1 ″	16.50	35.00

No. 1½	Gear	⅛″	Price	$ 9.00	With A.C. motor $25.00
No. 2	"	¼″	"	10.00	" " " 27.50
No. 3	"	⅜″	"	11.50	" " " 28.50
No. ¾	"	½″	"	12.50	" " " 32.00
No. 7	"	¾″	"	15.00	" " " 37.50
No. 9	"	1 ″	"	16.50	" " " 49.50
No. 11	"	1¼″	"	48.50	" " " on request



HEAVY DUTY TWIN COMPRESSOR

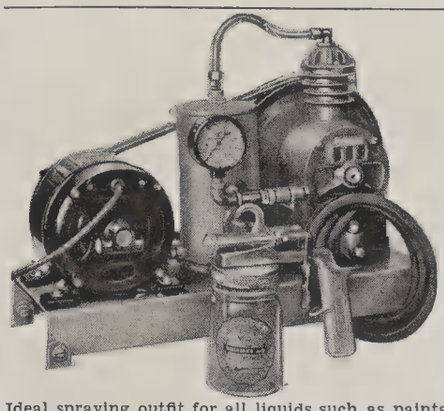
Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12″ x 24″ tank A.C. 110 or 220 v. 60 cycle $57.50

16″ x 30″ tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

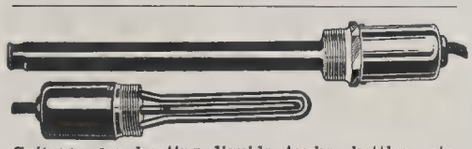


Ideal spraying outfit for all liquids such as paints, enamels, etc. Can also be used for cleaning, tire inflating, and general purposes. Equipped with General Electric ¼ HP. a.c. motor. Quincy air compressor, adjustable safety valve, and 100 lb. air gauge. A heavy duty Plummer spray gun with 15 feet of hose. Weighs only 60 lbs.
Price $45.00
Complete and ready for operation.

Synchronous Motors

New Emerson 100th H.P., 900 R.P.M. 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base. Has many applications.. $7.50

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½″ iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.

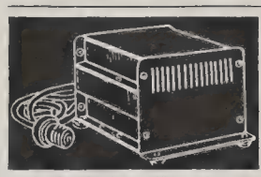
600 Watt..... $7.50 1200 Watt $10.50
750 " ..... 7.50 2000 " 12.50
3000 Watt $15.00

MAGNETIC GAS VALVES

All sizes in stock; Prices on request

Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums. Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat oak base. Complete. $7.95



COROZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC. Only 10 watts. $9.50

EXHAUST FANS, BUCKET BLADES

General Electric A.C. 110 volt motors.

	R.P.M.	cu. ft. per min.	Price
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1¼	¼	1750	950	7½″	6 ″	37.50
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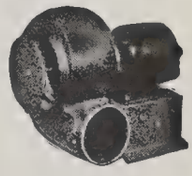

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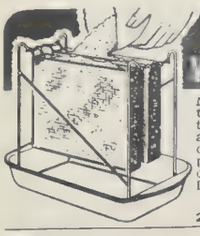

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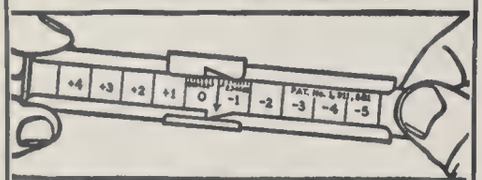

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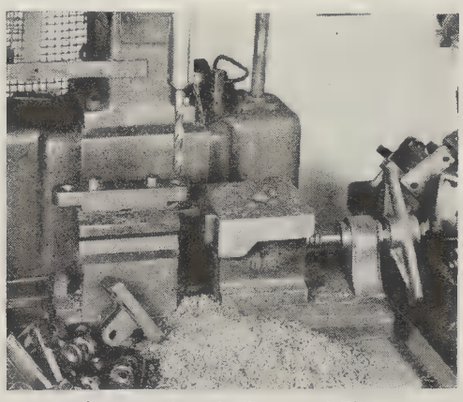
TIME SAVING

Vise Has Turret Jaws to Hold Many Shapes

TOOL room and other machinists can frequently reduce the amount of time necessary for turning out a special or a routine job by the use of the turret-jaw vise shown in one of our illustrations. The rear jaw of the vise can be



Set-up for duplicate drilling

turned through quarter circles, thus presenting four different faces, each of which has a surface adapted for holding various types of work.

Supplementing these jaws, which are unusually deep, are auxiliary jaws which can be bolted to the tops of the main jaws to hold almost any of the odd shapes constantly encountered in repair and tool work.

With the auxiliary jaws removed, drill or reamer bushings can be attached to the tops of the jaws and, with length stops attached at the sides, duplicate work can be turned out rapidly. The vise, known as the Jackson Time-Saving Vise, is made by the Brown Engineering Company.

PLASTICIZER

For Ethyl Cellulose, Has Excellent Solvent Action

FOR sheeting, molding, and extruding ethyl cellulose, as well as for use in lacquer films, a new plasticizer known as Theop has been developed by the Glyco Products Company.

Theop is a light-colored, synthetic ester which is commercially available. It is non-volatile, non-drying, non-corrosive and is completely compatible with ethyl cellulose. It has excellent solvent action and will dissolve ethyl cellulose in the cold. In ethyl cellulose formulations for molding, 30 percent Theop exhibits no exuding, discoloration, or other deleterious characteristics, either initially or on aging tests.

SOAP

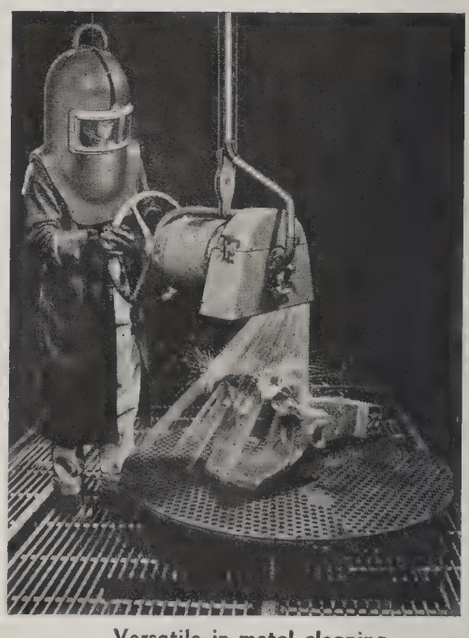
For Commercial Laundries Now in "Complete" Form

MODERN washing technique has resulted in the development of a "complete soap" whose introduction is rapidly supplanting the rule of thumb method of mixing soap and alkali, according to researchers of the National Oil Products Company, who have evolved a compounded mixture of anhydrous soap and a series of especially selected alkalies to which have been added solvents and penetrants. This complete soap was prepared for use by launderers in commercial and institutional work where maximum cleanliness, whiteness, and clean odor are essential. It possesses a uniform balance of alkali and soap plus solvent action and penetration.

BLAST CLEANER

Portable, Uses No Compressed Air

ADAPTABLE to the cleaning of a wide range of large and small, intricate or



Versatile in metal cleaning

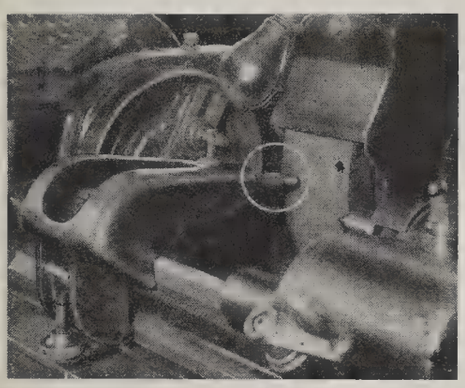
irregularly shaped work, a new portable metal cleaning unit has recently been introduced by the American Foundry Equipment Company. This blast cleaner, known as the Portable Wheelabrator, is suspended from the ceiling of a blast cleaning room, while objects such as lathe beds, flywheels, furnace castings, and so on, rest upon a perforated flooring or grill. The operator can quickly and easily direct the blast of abrasive from the nozzle of the unit so as to clean completely and thoroughly all surfaces of the work.

The abrasive—metallic shot or grit—is fed through a pipe from an overhead hopper. This abrasive is picked up by a wheel-like element within the unit, and is thrown by centrifugal force out through the mouth and against the work. Hence no air compressors, pressure tanks, or other equipment typical of air-blast cleaners are necessary.

WHEEL DRESSER

Alloy Matrix Holds Diamonds for Life

INDUSTRIAL diamonds embedded in a Carboloy matrix are used in the grinding wheel dresser shown in one of our illustrations. Because the Carboloy matrix is virtually impregnated with



Wheel dresser (in circle)

the diamonds, the dresser becomes a permanent fixture giving the greatest possible diamond utilization per carat, with no resetting expense throughout the long and useful life of the dresser.

RESIN INSULATOR

Bakes In Coating Resistant To Hot Oils, Water, Alcohol

METALS, fabrics, and various compositions may be given an electrical insulating coating with a new synthetic resin material recently announced by David C. Brown Company. This coating, which requires baking after application, withstands hot oils, salt spray, high voltages, and varying temperatures, is known as Resi-Flex. The coating has high dielectric strength and low power factor; one coat over any clean surface will stand up under 500 volts at 25 amperes.

The original liquid is of low viscosity and is furnished in water-clear solution only. Baking time runs from six to 30 minutes at 275 to 350 degrees, Fahrenheit, depending upon size of unit and type of material.

PYROMETER

For Industrial Temperatures, Is Direct Reading

CALIBRATED directly in degrees of temperature, an entirely new type of optical pyrometer is now available for

Telescope of new pyrometer

measuring temperatures accurately and conveniently.

Optically, this instrument, recently announced by Leeds and Northrup Company, employs the "disappearing-filament" method for precision temperature measurement.

The instrument consists of two parts: the telescope shown in one of our illustrations and its attendant potentiometer which is housed in a strong, light-weight casting equipped with straps to be suspended from the shoulders. On the potentiometer housing are the electrical controls.

To measure temperature of an incandescent object, the operator looks at it through the telescope which contains a glowing filament. He sees the filament either lighter or darker than its background. While he watches, he adjusts filament current, and consequently brightness, by turning a knob until the filament disappears—matches and merges with the object. Thus he adjusts filament brightness to equal that of the object. A slight turn of a second knob balances the potentiometer which is used to measure filament current, and which is calibrated directly in temperature degrees.

For temperatures from 1400 to 2250 Fahrenheit, filament and object are compared directly. For higher temperatures, the operator introduces an absorption screen.

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"We would like to have tarried [over Tokyo] and watched the later developments of fire and explosion, but even so we were fortunate to receive a fairly detailed report from the excited Japanese radio broadcasts. It took them several hours to calm down to deception and accusation." (Brig. Gen. James H. Doolittle in news reports of Tokyo bombing)
Interesting!
Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!
WITHOUT radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.
Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.
So today all our radio production centers on war use.
But what of tomorrow—what effect will this have upon the future—after victory?
One thing is certain—it will revolutionize and speed the great new future form of transportation.
Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.
But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.
And—mark this well—airplanes and radio are two of the four great industries destined to lead this country back to business normalcy after the peace is won.
Zenith's leadership in the radio industry has been established by a constant achievement of "firsts." Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios. And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio. We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.
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Aircraft Engines Get New Heads

Aluminum Forgings Replace Castings, Speeding Up Production and Releasing Needed Equipment

ALEXANDER KLEMIN
**Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University**

AFTER five years of research, the Wright Aeronautical Corporation has developed a revolutionary technique in aircraft engine manufacture, whereby the aluminum heads of the cylinder are forged instead of being cast.

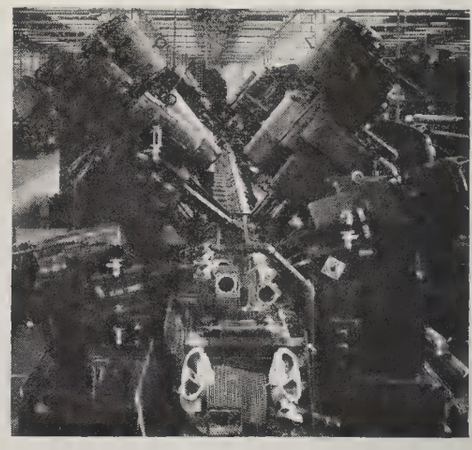
Here are the striking advantages of the new process: Nine separate drop-hammer operations required with the cast head are eliminated, thus leaving the now critically scarce drop hammers free for other uses in our war production program. Fabrication is speeded up, and there is a very large saving in material rejections. The forged head is much stronger, owing to its closer and more uniform grain, so that higher compression ratios and more power per cylinder become possible. In fact, on test the forged heads have withstood hydraulic pressures double those of the cast cylinder heads now in use. Still another advantage lies in the fact that the fins can be milled very closely so that cooling is greatly increased, an important point for the aircraft engine with its high specific output. Altogether, an increase in power of 12 or 15 percent may be expected which may mean definite superiority in a combat airplane.

In the fabrication of the forging, aluminum bar stock is extruded—that is, forced through a die—and emerges roughly in the shape of the desired forging. Then sections of the extruded

Forged cylinder head; rough stock

bar are pressed in a die to final shape. The forged cylinder head and the rough stock from which it is made are shown in one of our illustrations. Hand in hand with the design of the forged head came the development of machine tools which made it possible to turn out these heads much faster and more cheaply than the cast heads. To keep pace with the increased manufacturing speed of the forged head, the Wright Aeronautical Corporation installed many of the huge Greenlee automatic cylinder head transfer machines shown in another photograph. These machines are 154 feet long and combine the operations of 39 older type machines. Originally designed to operate on cast cylinders, the huge transfer unit performs automatic operations on the forged heads without any alteration of the multiple tooling.

There is, besides saving in time, a saving of valuable material, because 95 percent of the forgings will be turned into cylinder heads, while only 80 percent of the castings made the grade.



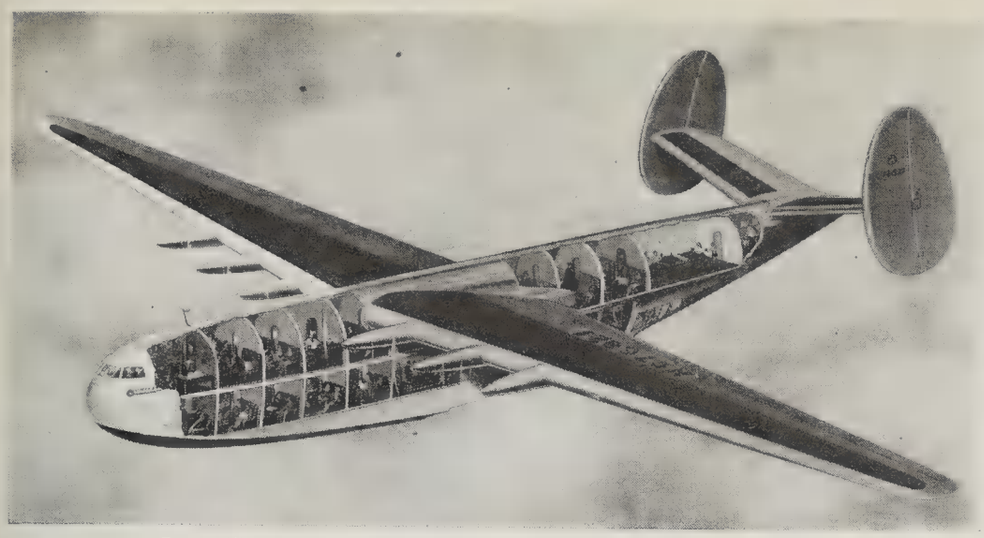
Does work of 39 machines

AIR ADVICE

Needed by the United States Army

SEVERSKY'S book, "Victory Through Air Power," has been reviewed so extensively and so favorably, that we shall not attempt a lengthy notice in these columns. We do feel impelled, however, to add the following remarks to the record:

It is quite possible that Seversky may have a feud with the commanding generals of the Army Air Force, but the younger men in the Air Force—the flying colonels and majors who are actually going to do the work of bombing—have tremendous respect and admiration for Major Seversky. They



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approve his analysis of the Battle of Britain; they agree with him fully on the superiority of land based aircraft; they are with him completely on the argument that an air offensive is *the* weapon to be used against Germany. They do not advise him to seek a commission in the Air Force, even with the rank of a general officer. At present, so these young and enthusiastic officers say, Major Seversky can say what he pleases and give the nation his immensely valuable views. Once inside the Army, he would be silenced and the United States would lose the benefit of advice from one of the few really noted air strategists of the world.—*A.K.*

AIR TRANSPORT

Can Rival Surface Ships in Yearly Volume

ALMOST every day some item of news confirms the view that air transportation is of vital importance to our war effort, and now, under the War Production Board, a committee has been formed to study the cargo plane in relationship to war transport. Grover Loening and other authorities point out that a large airplane could, because of its far greater speed, deliver more goods in a year than a large but slow freighter. The Army Air Transport Command and the Army Air Ferry Command have been combined into one unit. The subject of the towed glider is very much to the fore, and the German Junkers Ju-52 continues to haul men and materials to Libya, with and without the addition of the aerial trailer. Thus the announcement by Glenn L. Martin of a cargo plane of 250,000 pounds gross weight is quite timely.

One of our illustrations shows an artist's conception of the projected giant. Apparently it will be a land plane with six liquid-cooled engines submerged within the wing. It would be capable of carrying 102 passengers, each with 80 pounds of luggage, plus 25,000 pounds of mail and cargo, to London in 13 hours. As military transports such planes could carry large numbers of troops and heavy supplies. As commercial vessels, they would be able to rival, in a year of operation, the payload carrying capacity of surface vessels.—*A.K.*

THE "LEANS"

Caused by the Human Ear

A CURIOUS sensation sometimes experienced by pilots, and termed the "leans," has recently been described by Harold G. Crowley of the Safety Bureau of the Civil Aeronautics Board. Professional pilots have considerable reticence in discussing this phenomenon; they seem to think that experiencing the so-called "leans" may indicate some physical abnormality. As a matter of fact, there is no such question involved, and the sensation may be experienced by anyone. Here's what leads up to it: During instrument flight, a slow lateral tilting of the aircraft remains unnoticed and uncorrected up to a certain point. When finally the tilting has become pronounced enough for the pilot to be aware of it, he corrects the attitude of the plane in a much shorter period of time than that which was required for the original tipping.

Now the human ear is so constructed that it readily notes rapid acceleration but not slow acceleration. The ear, therefore, does not recognize the slow tilting but does take cognizance of the rapid recovery motion. The result is that, if the gradual tipping was down on the right side, the pilot ends up with the sensation (called the "leans") that the plane is now tipping down on the left side, even though the instruments tell him that the airplane is on even keel.—*A.K.*

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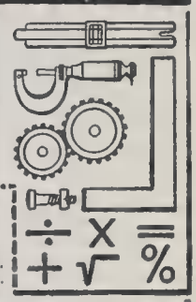

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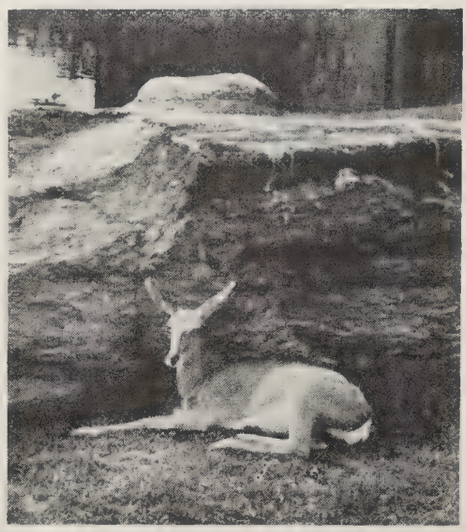
When You Can't Get Close

THE one-lens photographer, which means most of us, has to make that one do for everything, whether close-up or otherwise. What to do at the zoo, for example, when photographers must remain at some distance from the subject, as in the case of the fawn in this picture. You can do



". . . to concentrate the eyes"

one of two things: crop the portion you want, which frequently is not feasible because the wanted material occupies but a small portion of the negative area, or keep the subject relatively small and include the surroundings. The latter usually is not feasible either because so many distracting elements appear. Occasionally, however, inclusion of surroundings lends atmosphere, as well as identifying locale, as in the illustration. A couple of ducks in the water were spotted out, as were also some insistent highlights on the rock. Partial burning in of the upper half of the picture as well as the foreground helped to bring down the tones in these areas and to concentrate the eyes on the fawn.

New Exhibit Method

WITH direction by Lieutenant Commander Edward Steichen, U.S.N.R., and descriptive-interpretive captions by Carl Sandburg, an unusual photographic exhibition designed by Herbert Bayer was recently placed on view at The Museum of Modern Art, New York City, under the name, "Road to Victory." The show is not an exhibition in the ordinary sense of the term, which is understood to mean a collection of prints on mounts displayed uniformly on a wall, but something more in the nature of a still travelogue of America's resources and how these are being put to use in the gigantic war effort to back up "the man behind the gun."

The unique feature of the show is the variety of display ideas. The majority of the pictures, all of which were taken from the files of governmental agencies, large news picture agencies, and other sources, are huge enlargements, or murals. The arrangement is given a three-dimensional atmosphere by such devices as suspending prints by wires from the ceiling, by arranging the pictures on the floor suitably tilted for convenient viewing, by ingenious juxtaposing of prints on walls and floor, by a planned viewing sequence routine, by the use of railings to fix the viewing distances, and other means.

A copy of a booklet containing many photographs showing the arrangement of the show as well as the text, can be obtained by writing the museum at 11 West 53rd Street.

Where Have You Filmed?

IF you have ever taken travel movies, still pictures, or transparencies outside the United States, your Government is interested in what you have. Your pictures may be instrumental in helping win the war. Such pictures sometimes prove invaluable in piecing together vital information. Acting on the request of authorities of the United States Government, the Amateur Cinema League, Inc., has assumed the task of soliciting these pictures and to make them available to the Government. "Quality is unimportant; subject matter is paramount," writes Roy W. Winton, managing director of the League. Questionnaire forms may be obtained from photographic dealers or from the League, 420 Lexington Avenue, New York City.

Contreflash

CONTREJOUR, or against-the-light photography, has its counterpart in flash work. One example is illustrated. The flash reflector was used on extension, and the legs of the foreground subject, the "frame," provided the necessary shield. As a result, the photographer and camera were in perfect silhouette, while the photographed subjects received the illumination. This technique lends itself to many variations and has frequently been employed for unusual effects in flash photog-

The frame provides the shield

raphy. As in contrejour work, two important precautions must be watched: make sure the light does not hit the lens; shield the light appropriately so that it does not spill over into the area that is to remain dark.

Hair Aids Composition

IN COMPOSING portraits, the hairdress of the woman subject usually receives little attention aside from the use of a

"Portrait of a Ballerina"

spotlight to give sparkle and body to the hair and to provide separation from the background. Sometimes, however, it is possible, in the case of subjects with long tresses or curls, artificial or otherwise, to make use of hair in arranging the composition a little differently from the ordinary shot. In the present instance—a portrait of the ballerina, Miya Slavenska—the curls resting on the shoulder not only help the arrangement but are almost necessary in view of the pose. The tilt of the head is on the border line between strain and naturalness; the curls seem to relieve strain and help balance the composition at the same time.

Reducing Chemical Fog

IF YOU have been consistently getting aerial or chemical fog in your negatives, the fault may be minimized by adding a little desensitizer to the developing solution. Be sure the desensitizer is the type that may be mixed with developer, such as Pinakryptol Green.

Separation Negatives

SOME beautifully done color prints we saw the other day, at a demonstration of color printing, gave us revived hope in the future of color photography for the general worker. The results left nothing to be desired. As one person remarked, they were "better than paintings." However that may be, satisfaction was universal. Nevertheless, the question was put to the demonstrator: "The separation negatives from which you are working were made in a one-shot color camera, of course?" intimating that separations made from Kodachrome transparencies could not have produced such excellent color values in the print. "Not at all," said the demonstrator. "While it is more convenient to use the one-shot color camera and thus obtain three separations direct and at one time, I personally prefer to make my own separations from Kodachromes because then I can control the exposures for the individual separations, whereas in the one-shot I have to take what I can get, which is frequently a compromise."

ASA Computer

DESIGNED for the Army and Navy photographers for use in any part of the world, any time of the year under all daylight conditions, a Photographic Exposure Computer, produced by the American Standards Association, is now available for civilian use as well. A 24-page booklet with fabricoid cover, the computer has a movable dial calculator which correlates light condition, the scene's reflective powers, and the speed of the film used, offering the photographer a choice of lens stops and shutter speeds for the particular conditions involved. Compiled from observations by the Smithsonian Institute and the United States Weather Bureau over a period of years, the computer includes tables indicating the amount of light available at any point on the earth's surface for a given month and hour, as well as other useful data.

Opposing Diagonals

GROUP pictures, especially when taken semi-candid-wise, as this one was, are not easy to compose. In this flash shot of Bruce Downes, newspaper editor and camera columnist, and his wife, Bruce

"Laughing Diagonals"

sat on the arm of the chair and leaned over at a rather acute angle. When someone cracked a joke, both looked his way, the lady characteristically tilting her head a bit, with the result that the camera caught two sprightly diagonals. Spontaneity of pose and expression plus unusual composition were both well served.

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AIR RAID SHELTERS

By A. D. Rathbone, IV

(*Continued from page* 117)

rent when it is remembered that, of the 168 hours in the week, the average citizen works at his place of business 40 to 48 hours, and spends 12 to 20 hours in the streets and other public places, and the remainder of the time (about 100 hours a week) at home. This means that during the weekly cycle of urban life the chances are about three out of five that if the community is bombed, the attack will occur while the working people are at home. Actually, the chances of an individual being bombed at home are even greater than three out of five, since the large majority of the urban population work in the daytime, whereas most air raids are carried on at night, and since the non-working members of the family spend an even larger percentage of their time at home."

For the householder, there are three general methods of shelter protection: (1) Underground, either in the yard or beneath the house; (2) surface, or semi-surface, either attached to or inside the house; (3) a "refuge" room. The latter is not as effective as the first two, especially in houses of light, wooden construction, but it is much less expensive and can be accomplished by anyone with a little ingenuity. In this latter category comes the British Morrison "mouse-trap," regarded in the opinion of some professional engineers as the most adequate indoor method of protection. Designed for ordinary use as a table, the Morrison has a steel roof, or top, mounted on steel legs. It is 30 inches high, four feet wide, six and one-half feet long, its sides are of steel or heavy wire mesh, and it will accommodate a man, his wife, and one child. This offers only emergency and primary protection from falling debris and should not, therefore be expected to withstand more of a load than the collapse of an average two story dwelling. By the same token, there should be no cellar or other excavation beneath it into which it could fall.

A British type of semi-surface shelter, the Anderson, is shown in one of our illustrations. These are constructed in various sizes, they have proved reasonably safe and satisfactory as protection against bomb blast and splinters, but they require a considerable amount of heavy galvanized sheeting, or elephant iron, to build. An American commercial prototype of the Anderson which obviates the use of our precious steel supply is The Solid Timber Shelter, made in either table form or arch shape, the latter being shown in one of our illustrations. Both are designed for indoor use, and it is claimed the arch shelter has withstood tests which prove it capable of protection against 10 tons of debris, while the table style is reported built to take almost double the load of the Morrison. Constructed of four-inch timbers, either type is designed to safeguard dwelling occupants from dangers of falling debris, flying glass, and, to some extent, bomb concussions. Any house type of shelter, either indoor or outdoor, helps in the vitally important problem of keeping the civilian population thinly spread out during an air raid and of keeping parents and children from becoming separated.

As to private shelters in yards, just about anything from an open trench, wide enough and long enough in which to lie flat, to the more complicated, more expensive steel (if you can get it), concrete, or sheet-iron constructions will provide splinter protection and reasonable safety from the devastating blast of a bursting bomb. Although bombs in this war are bigger, more destructive, and more varied in type than in the last conflict, this writer inscribed the following in his diary under date of August 21, 1917, after his first experience with German bombs, and it is as applicable today as then: ". . . every man who could conscientiously leave his post ran like mad for cover. 'Cover' usually consisted of throwing oneself as forcibly as possible upon the ground in a gutter or close to a building. The man who could throw himself most forcibly and cling the closest to earth was the safest." That technique, in the absence of any form of physical protection, is still recognized as good—and it requires little or no practice to attain perfection!

As to modern office buildings, skyscrapers, apartment houses, the problem is different and varies with the structure. Again, and above all else, obey the regulations established for your particular building, keep cool, and obey the warden in charge. Go to any interior rooms or hallways above the first, and preferably above the second floor, but avoid the roof and upper floors. If no interior rooms are available, stay away from windows, but open them.

Lack of space prevents presentation of complete details on this many-sided subject of civilian protection in case of enemy air-raids. There have been, however, a number of excellent books published, some technically inclined for guidance of those responsible for providing safety to the public, and others designed primarily for public consumption. The Office of Civilian Defense in your locality can also help.

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As THE little note on page 98, explaining the cover picture, states, the 200" telescope on Mt. Palomar, California, is now locked up tight as a drum for the duration of the war. The former working force is doing things that directly help win the war, in order that we may continue to have astronomy according to science and not according to the Nazis. No doubt, if the Nazis won, all the astronomies would be called in and burned, and new ones issued teaching all coming generations that the Sun is Hitler in Heaven.

George Herbig, one of the more prominent amateur telescope makers in Los Angeles and now connected with the Griffith Observatory (planetarium) there, writes that he visited Mt. Palomar Observatory before it was closed up, and took the cover picture.

This is no ordinary photograph. As anyone knows, who has tried to photograph a telescope within its observatory dome, it is most difficult to obtain points of view that take in the whole instrument—usually one gets only various parts. Herbig did not knock out one wall of the building, but luckily found the yoke and tube so positioned that he could shoot partly upward from below and get an excellent general view of the whole. The ladders propped against the mounting give the scale. The object in the lower left foreground is the aluminizing tank—really a gigantic affair, Herbig states.

There is no use arguing that the 200" is beautiful. It's a plug-ugly, like a big square-toed, hobnailed boot. But it wasn't designed for sex appeal. Functionability was the true governing principle in the design and no real sacrifices were made to beauty, as this would be criminal. So it's simply a he telescope, unashamed.

Figure 1 shows the main worm wheel for the R. A. drive of the 200" telescope. This is 11' in diameter and the spacing error of the teeth is one second of arc, or one part in about a million and a half. The man shown worshipping is M. K. Baughman, technician of the Griffith Observatory. George Herbig took this photograph also.

GENERALLY, in precision optics, surfaces are worked to a tolerance of one eighth of a wavelength, or around 1/400,000". But not all of them. Suppose light is to be reflected from two surfaces, serially; or three, serially. The tolerance then becomes smaller. The 200" mirror, for example, is to be worked to a tolerance of 1/20 wavelength—just about a millionth of an inch. This is to be done because in certain combinations of its auxiliary mirrors there will be six reflections, serially.

This 1/20 wavelength is simply an attenuated case of the famous Rayleigh tolerance, described in Conrady's "Applied Optics and Optical Design." For one reflecting surface the tolerance is ⅛ wavelength. For n surfaces in series it becomes $1/(8\sqrt{n})$ and where there are six reflections this is approximately 1/20. Summarizing the matter, H. H. Selby says in a letter:

"Maximum phase difference at ultimate focus for all rays should be less than ¼ wavelength, ⅛ for perfect definition.

"Assuming a smooth surface, a zone one wavelength out of position will introduce two wavelengths' path difference at focus, for one reflection.

"If $(n—1)$ surfaces are interposed between the first surface and the focus, least squares treatment indicates that a total of n reflections will have an average of the square root of n effect.

"Assuming that each surface adds an error in a common direction (either plus or minus), the summation of path differences must be less than 1/8 wavelength, and the first surface must contribute no more than $1/(8\sqrt{n})$. For six reflections this is approximately 1/20 wavelength."

All of this being the case, but often lost sight of, it seems that where two surfaces are involved, the tolerance should be pushed up a bit, to about 1/11 wavelength—at least where perfection is the high aim. It is one argument against tackling Cassegrainians lightly.

Figure 1: Worm wheel of 200"

OWNERS of the book "Amateur Telescope Making—Advanced" will recall, in that book, page 319, a description of a drive for a fine 12½" telescope made by Alan Gee and C. Carvel Diller, the former then a cadet at the West Point Military Academy. Gee, now a Captain in the 18th Engineers at Vancover Barracks, Washington, where he is working on a 20½" Cassegrainian in conjunction with two Portland amateurs, sends in the following, with the statement that by the time it is in print he may be elsewhere.

"Here is my contribution to the Cassegrainian secondary problem.

"It is impracticable to test the hyperboloidal convex through the back, so as to consider it a concave. However, it is practical to test a concave hyperboloidal test mirror and then use this mirror to test the convex by means of interference fringes.

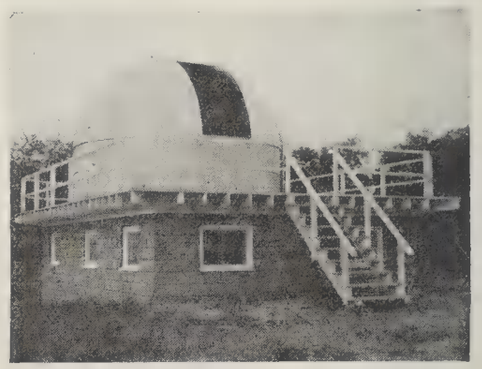


Figure 2: Gamble's ideal hideout

"What I propose is this. Determine radius of curvature of the secondary by the usual method. Grind and fine grind to this curve. Then set aside the convex mirror and polish the tool, which of course is of the same curve as the secondary except it is a concave. The tool need not be polished to the perfect degree required of the finished secondary, but should be fairly well polished.

"Then figure the concave tool to a hyperboloidal curve, using the good old Foucault test and the following formula to determine the radii of the various zones.

$$R = \frac{(P' + P)^2 \sqrt{r^2 + P'P}}{2(P' - P)\sqrt{P'P}} - \frac{(P' - P)}{2}$$

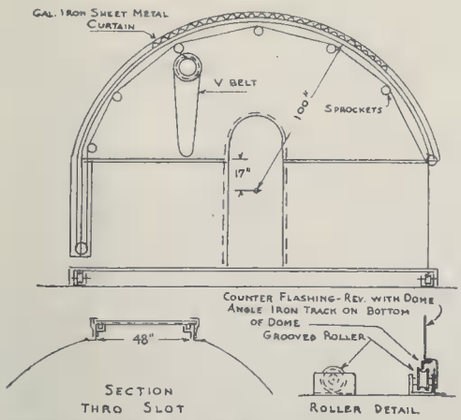
[The symbols are the standard ones of Ritchey—see "A. T. M.," page 62.—*Ed.*]

"Obviously, the same procedure would work for testing the spherical convex of a modified Cass. The test mirror would of course be figured spherical.

"This method sounds long and difficult, but remember that you already have the concave test mirror fine ground to the correct radius, and that only a few hours of polishing will be sufficient to permit figuring and testing by interference fringes. Also the test mirror need not be wasted after the job. It can readily be refigured into a good paraboloidal primary.

"I inclose my derivation of the above formula in case some of your math nuts would like to try to pick it apart." [Available to math maniacs, on request.—*Ed.*]

Gee says he and his co-workers are using this test on the 6″ secondary of the 20½″ mirror, which is an old Tinsley replica of the 200″ mirror with prime focus 80″. Secondary focus is to be



Redrawn by R. W. Porter

Figure 3: Gamble's dome details

240″, hence overall *f* ratio is about 12. English type mounting. Split ring outer bearing, allowing the Pole to be reached. It will be extremely heavy and rugged, he adds.

ON a bluff just outside Moline, Illinois, overlooking a valley and with an excellent horizon, stands the observatory shown in Figure 2, built by Carl H. Gamble, R.F.D. 1, that city. It contains a 5½″ Zeiss refractor on a Clarke mounting.

Lower story of the observatory houses the owner's science library in a room 18′ by 20′, which also will accommodate the members of the local club of amateur astronomers. Above is a deck 22′ by 32′, and on this is the spacious dome, 16′ 8″ in diameter—just the size, by the way, of the 200″ *mirror* in California!

Details of this neatly designed dome and slot cover are of especial interest (Figure 3). The former is a steel silo top made by Lamneck Products, Inc., Middletown, Ohio—similar to domed silo tops made by a number of manufacturers. For example, The Independent Silo Co., of St. Paul, Minn. Entire dome rotates on eight rollers near the floor level, the conventional fixed wall thus being eliminated. In this respect it is similar to the type shown in "Amateur Telescope Making—Advanced," page 493, Figure 13.

DURING the soul-trying work of making a first telescope mirror, when it is altogether natural to entertain misgivings whether the claim that an amateur can make his own telescope mirror is true, something is needed to bolster or shore up the morale of the poor, lonely, and perhaps wavering worker.

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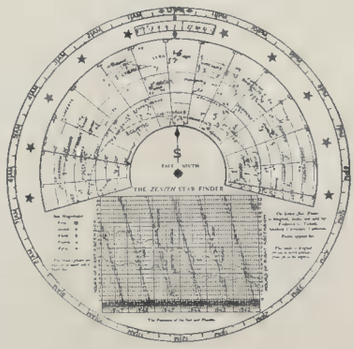

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The famous Brashear, in his Autobiography (page 49), tells of doing this. I, too, have done it. Sunspots can be studied (always using two pieces of smoked glass between eyepiece and diagonal), the Moon's major features can be seen, likewise the phases of Venus. I saw all those fairly well when the figure still was a rank hyperbola. It renewed my courage."

The tyro may, however, encounter one lesser discouragement in connection with doing this—collimation of the mounting to hold the mirror. This usually is a tough, cussed job. Perhaps, if told in advance that it usually is such, and thus led to expect it—for most owners have been through that same mean stretch and few have found it otherwise—this setback to morale won't seem so big.

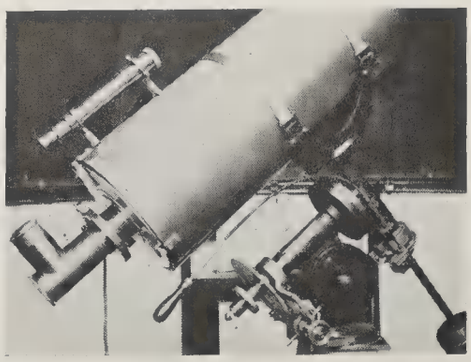


Figure 4: Coates' 8" Gregorian

AFTER completing an 8", *f*/8 Newtonian, a 6" Richest-field telescope, and a 10" Gregorian (Figure 4), Ernest L. Coates, 6432 Perry Ave., St. Louis, Mo., built the attractive backyard observatory shown in Figure 5.

He made the patterns for the castings used in the mounting of the Gregorian and had the castings made and machined outside. The telescope has a motor drive and is equipped with setting circles. Coates made a battery of eyepieces, from ⅛" to 2½" efl, using Crystallex glass obtained from the Pittsburgh Plate Glass Company, and found this choice, clear, plate glass sufficiently satisfactory. The Gregorian proved to be successful—sharp images—but Coates finds the field of view rather small, the only complaint he named.

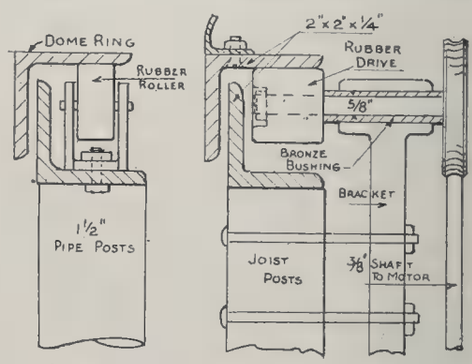
Figure 5: The Coates Observatory

The Coates Observatory is all metal, 10′ in diameter, and is supported on eight 1½" iron pipes set in concrete. Its sides are of 26-gage galvanized iron. Both circles—the one on the dome and that on the fixed base—are of iron and are welded in one piece. Dome ribs are 1/8" x 1" flat iron stock. The one-piece shutter rolls to one side on grooved rollers running on angle iron track and Coates states that it does not clog with ice. A 1/6 horsepower motor rotates the dome at one turn in two minutes.

The dome is mounted (Figure 6) on 18 rubber rollers and is noiseless when moving. There are six guide rollers to hold it in position. The slot opening is 30" wide. The drive (Figure 6) is of the friction type.

The dome is painted dull black inside (lampblack, alcohol, enough shellac for binder), and with aluminum outside.

PROFANITY is traditionally the chief by-product of making a pitch lap—at least during the first 10,000 attempts. New stunt (so far as is known) is offered by



Redrawn by R. W. Porter

Figure 6: Coates' dome details

A. Rowland, 909 Easton Bldg., Oakland, Calif.

The two disks are warmed, the face of the mirror disk is given a thin coating of common vaseline, and the two disks are stood on edge, side by side, separated by the thickness of the desired lap, on a strip of heavy adhesive paper. Next, the paper is rolled around the disks and is stuck fast to them. Some kind of props can be used to hold the disks in place for the pouring, if desired. A pouring cup or funnel, of modeling clay, is set on top, over a hole punched in the paper, and the melted pitch is poured in till it reaches the top and ceases to settle. The whole unit is then set in a cool place for the pitch to set *fully*.

To remove the mirror, Rowland states, he first rests the unit on small blocks in a basin, with the mirror disk down, and then pours in enough cold water to submerge its lower half. He brings the water slowly up to about 100° (average hand-washing water) in not less than 20 minutes—otherwise, risk of cracking. He next removes the unit, lays it on a bench, tool side down, and places a strap or strip of cloth around the tool, half a turn with the two ends extending in the direction of an assistant whose job is to hold them. Then he places a similar strip around the mirror and pulls in the opposite direction.

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POWER SOURCES OF THE FUTURE . . . Page 164

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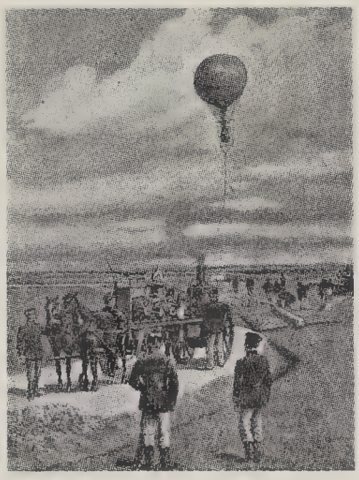
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1892)

TELEPHONE—"The perfection of the science of long distance telephony has been going on for the past five or six years, until an epoch of much interest has finally been reached; that is the perfect transmission of articulate speech for a distance of one thousand miles and over. . . An important element in the success of long distance telephony is the improved battery now used for energizing the transmitter, which has the merit of maintaining a nearly uniform electro-motive force of high tension for an extensive period of time. . . The long distance transmitter also has been improved by using in it one uniform size of carbon granules, obtained by passing them through a sieve of a certain mesh."

BALLOONS—"In Europe, the principal governments now have ballooning corps attached to their armies, by means of which observing balloons may be readily transported and quickly inflated on the field. . . The German military balloon car is suspended from a trapeze, which lessens its oscillation. . . The rope-winding mechanism, by which the height of the balloon is regulated, is arranged upon a strong wagon, and is operated by a steam engine, the whole presenting the general appearance of a steam fire engine. The hydrogen gas for inflating the balloon is carried to the field in highly condensed form in separate steel cylinders. In operation a central steel cylinder, of larger size than the others, is laid upon the ground and the smaller cylinders are then attached to its sides. A flexible pipe at one end of the large cylinder conducts the gas to the balloon."



CHOLERA—"In Asia and Russia the cholera has carried off many thousands of poor people, chiefly by reason of the filth in which the victims lived and the lack of proper medical treatment. In Europe the disease made no alarming progress, except in Hamburg, where it was brought from Russia, and, owing to the dirty condition of the town and the supineness of the authorities in adopting proper sanitary measures, the advance of the disease became rapid and ominous. . . Hamburg is notorious for its crowded and filthy tenements. . . It is a peculiarity of this disease that its spread may be readily checked and controlled by the early adoption of intelligent precautionary means and regulations."

BAKU—"The supply of crude petroleum at Baku, on the Caspian Sea, is apparently inexhaustible, but until within the last ten years the town has been practically isolated from the rest of Europe, a long and troublesome journey being required to get to it. This has now been changed, and Baku at present has steam communication with all parts of Europe. The Nobel brothers have borne a prominent part in developing the petroleum industry here, laying the first pipe lines, employing tank steamers for conveying the product, and taking the lead in employing petroleum as fuel for the steamers. There is now not a vessel on the Caspian using wood or coal, liquid fuel being employed exclusively."

AMPHIBIAN—"Seldom have land and water been laid under contribution by a single mechanical device. It remained for the genius of a citizen of Chicago to devise a machine for both use and pleasure, which should enable his fellows to traverse with great speed either land or water, proceeding readily from one on to the other. . . It consists of twin boats rigidly connected and a tricycle connected to said boats so ingeniously aranged that the machine is propelled and steered by the same mechanism. This machine has the most perfect stability in either element."

TRACTOR—"Peter Chalmers, a farmer, is a genius in his line. When anything new comes out he studies to see whether it cannot be adapted to use on his farm. . . All the plowing done on Chalmers' big ranch is done with a traction engine. . . Now the farmer is hauling wheat to town with his engine. He brought a load in recently and stored it at the Stockton Warehouse There were nine wagons in the train, and each carried sixty-eight sacks of grain. Each sack weighs, on an average, 137 pounds, so each wagon load was 9,316 pounds, and the aggregate of all the wagon loads 83,844, or nearly forty-two tons. . . The engine can haul the train at the rate of four miles and a half an hour, but to prevent jolting the speed is regulated to about three miles an hour."

EDISON—"The village of Ogden, N. J., now known as Edison, has been built up within the last two years. . . When Mr. Edison invented the magnetic ore separator, he organized the New Jersey and Pennsylvania Concentration Company, and a plant was established at Ogden, the name of which was then changed to Edison. The ore as taken from the mine is run through enormous crushing machines, and then passed through the Edison separator, where powerful magnets attract all the metal, which is afterward run into pigs."

SOUND STEAMER—"The new twin-screw steamboat Richard Peck, built by the Narlan & Hollingsworth Company, at Wilmington, Del., for the New Haven steamboat line, made 20¼ miles an hour on her trial trip recently. The boat is 316 feet long over all, 48 feet beam over guards, and has a depth of hold of 18½ feet. Her horse power is 4,000 and her gross tonnage is 2,906."

FAN—"A fan attachment for rocking chairs is to be applied to a platform rocker, and, as one rocks backward and forward, a continuous rotary movement will be imparted to a fan held above the occupant of the chair, affording a constant and refreshing current of air."

COAST-WISE—"The proposal to establish an inland waterway between the Atlantic coast cities is once more under consideration. In its amplest form such a route would extend from Massachusetts Bay to Texas, making use of sounds and bayous as well as of existing canals as far as possible. This form of the enterprise contemplates the cutting of three new canals, through Cape Cod, Maryland, and the Florida peninsula; and as its expense would mount into the hundred millions, it is not likely to find favor at present."

Personalities in Industry

DR. CHARLES B. JOLLIFFE

AWARE that this is a "radio war" as much as it is a clash of mechanized forces, Dr. Charles Byron Jolliffe, Assistant to the President, Radio Corporation of America, and Chief Engineer, RCA Laboratories, is giving every ounce of his energy to furthering the all-important role of radio in supplying the "nervous system" for the nation's war machine.

"Radio provides the long-range eyes and ears of field troops, tanks, airplanes, and warships," says Dr. Jolliffe. "Therefore, it is up to the American radio industry to see to it that our armed forces are equipped with radio 'eyes and ears' that will out-perform anything that the Axis powers may devise."

Holding down a multi-phased job of liaison, technical counsel, and coordination between his company, all the activities of which are closely geared to the war effort, and various Government officials and agencies is Dr. Jolliffe's personal way of outdoing the enemy.

As Chief Engineer of RCA Laboratories—a post that includes direction of the RCA Frequency Bureau—Dr. Jolliffe directs and coordinates the broad engineering policies of RCA, represents the corporation, and directs its representation before public and governmental bodies.

As vice-chairman of Division C of the National Defense Research Committee, Office of Scientific Research and Development; as secretary of the Industry Advisory Committee of the Defense Communications Board; and as a member of the Engineers Defense Board, he contributes liberally of his broad knowledge of radio practices and potentialities.

In fact, Dr. Jolliffe is equipped by education, training, and experience as few other men are for his multiplicity of responsibilities. A big man physically, he has a big capacity for labor. Ask him how he is able to accomplish as much as he does, and he replies: "I just go ahead and do the job." There is more to it than that, however. Some of his associates say that he has been known to work twenty-four hours at a stretch. This doesn't mean that he works that way as a rule, but it does signify his willingness to keep going until the job at hand is completed.

Born in Mannington, West Virginia, November 13, 1894, he developed an early interest in physics and chemistry, concentrating on these two subjects at West Virginia University, from where he was graduated, with a bachelor's degree in science, in 1915.

During the years from 1915 to 1922, he continued his studies while serving as an instructor of physics at West Virginia University and Cornell University. He won his M.S. from West Virginia in 1920 and his Ph.D. from Cornell in 1922. Also in this period, from March, 1918, to February, 1919, he was attached to the United States Army Air Service, Science and Research Division. In May of this year, Dr. Jolliffe was awarded the honorary degree of LL.D. by West Virginia University.

From 1922 to 1930, Dr. Jolliffe was a physicist in the Radio Section of the U. S. Bureau of Standards, Washington, D. C., rising to the position of Assistant Chief of the Section. His research on radio-wave propagation and the development and maintenance of frequency standards resulted in several scientific publications and helped to form the basis for regulations which brought order out of the chaos into which broadcasting had fallen.

In March, 1930, Dr. Jolliffe was appointed Chief Engineer of the Federal Radio Commission, continuing in this capacity when the organization was changed to the Federal Communications Commission in July, 1934. He resigned from the FCC in November, 1935, to become Engineer-in-Charge of the RCA Frequency Bureau. He was appointed Chief Engineer, RCA Laboratories, in March, 1941, and Assistant to the President, RCA, in January, 1942.

98TH YEAR SCIENTIFIC AMERICAN OCTOBER 1942

SLENDER, SPEEDY, SCRAPPY

Destroyers Are Highly Important Factors in Naval Warfare

WALTON L. ROBINSON

OF THE various types of combatant ships in the world's navies the destroyer is, without doubt, the most versatile and hardest fighting. Armed with torpedoes, guns, and depth charges, she is a deadly menace to the enemy on, above, and beneath the sea. Long, slender, and speedy, she possesses great maneuverability and hence offers an exceptionally difficult target to hostile warships, aircraft, or submarines. But once hit by a torpedo, bomb, or heavy shell, the destroyer is in a serious plight, for her construction is very fragile and not intended to withstand any really hard blows. The experience last year, however, of the U.S.S. *Kearney,* one of our latest destroyers, is an excellent example of the severe punishment one of these boats can sometimes receive and yet reach port under her own power.

America and Britain urgently need more and more destroyers and other anti-submarine craft to combat the grave Axis U-boat threat in the North Atlantic. We must have as many destroyers and sub-chasers as possible in order to smash the enemy's U-boats faster than he can turn out new ones. Destroyers are, everything considered, the best all-'round anti-submarine type yet developed, especially for deep-sea convoy work. These remarkable boats can also perform several other important missions, among them torpedo attacks on hostile battleships, aircraft carriers, and cruisers in a major engagement. Their various functions were fully covered in an article which appeared in Scientific American for February, 1942.

The United States Navy is exceptionally well provided with destroyers. Our shipyards, furthermore, are turning out new ones at an astonishing rate. As of December 1, 1941—just a week before Pearl Harbor—we had 171 destroyers in commission and 191 others under construction or on order. Britain possessed some 230 in service and Japan about 125, of which at least 20 were small units (torpedo boats) of only 500 to 800 tons.

● Fourth analytical article of a series on ships of the United States Navy. The fifth, on submarines, is scheduled for publication in November. Previous articles were on battleships, carriers, and cruisers, published in May, August, and September of this year. —The Editor. ●

OUR destroyer strength included *72* boats of World War I vintage. With the exception of the 920-ton *Allen,* all of these old destroyers were of the well-known "flush deck" type. The *Allen,* completed in 1917, was of still earlier design and the sole survivor of her class. Her armament consists of four 4-inch, 50-caliber guns, two 3-inch, 23-caliber anti-aircraft weapons, and twelve torpedo tubes firing "tin fish" of 21-inch diameter. Designed speed is 29.5 knots, obtained by 17,000-horsepower geared turbine engines driving two propellers. Although having four funnels like the "flush deckers," the *Allen* can easily be distinguished from them by her raised or broken forecastle. Despite her 25 years, of which 18 were spent in reserve, she can still make things quite uncomfortable for Axis undersea raiders.

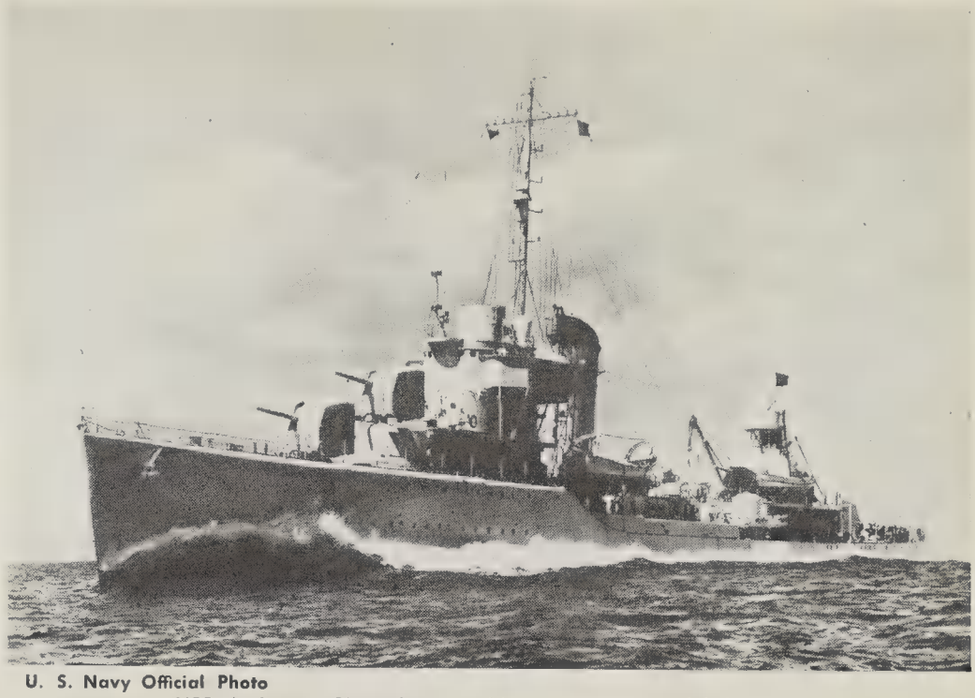
The "flush deckers," commissioned between 1918 and 1922, were the survivors of a class which at one time consisted of 273 units. Eleven had been lost by shipwreck or other accident, 93 stricken from the list and sold or scrapped, 50 traded to Britain for base rights, and one, the *Reuben James,* sunk by a Nazi U-boat (October 31, 1941). The remaining 46, their torpedo tubes and some of their guns removed, were serving in various auxiliary capacities: 16 as fast minesweepers, 14 as seaplane tenders, 8 as light minelayers, 6 as fast transports for Marine landing forces, and 2 as experimental vessels.

The 71 units still rated as destroyers ranged in displacement from 1060 to 1193 tons and were armed or had originally been armed with twelve 21-inch torpedo tubes in triple deck mountings, two on either beam. All of them carried four 4-inch guns except the *Brooks, Fox, Gilmer, Hatfield,* and *Kane,* which had four 5-inch, 51-caliber weapons.

ALL of these destroyers are now very nearly worn out, but, like the *Allen,* can still engage effectively in anti-submarine work. Most of them are believed to be on escort and patrol duty in the Atlantic. Others, presumably, were with the Asiatic Fleet when hostilities with Japan commenced. They acquitted themselves well, particularly in night torpedo attacks on heavily escorted Jap convoys in the Macassar, Lombak, and Bali Straits, and in the ill-starred cruiser action of the Java Sea. Eight of them were lost during the first six months of war: the *Pope, Stewart, Pillsbury, Edsall,* and *Peary* in the Far East and the *Jacob Jones, Truxton,* and *Sturtevant* in the Atlantic.

A decade passed between the commissioning of the last of the "flush deckers" and the laying down of the U.S.S. *Farragut*—the first of our rapidly expanding force of modern destroyers. Work on the *Farragut* was begun in September, 1932, by the Bethlehem Steel Company, Quincy, Massachusetts. Seven sister boats were laid down during the next year and a half. All eight units were completed in 1934-35 at an average cost of over

$3,500,000. Their displacements range from the 1345 tons of the *Dewey* to the 1410 tons of the *Worden*. They mount five 5-inch, 38-caliber "dual purpose" guns, four or more 1.1-inch anti-aircraft machine guns, and eight 21-inch torpedo tubes in quadruple mounts along the center-line. Geared turbine engines, developing 42,800 horsepower and driving two screws, give the *Farraguts* a designed speed of 36.5 knots. Trial speeds in excess of 41 knots have been reported. Four Yarrow high-pressure boilers provide steam for the turbines. Oil fuel capacity is 400 tons, sufficient for a cruising range of well over 6000 miles.



U. S. Navy Official Photo

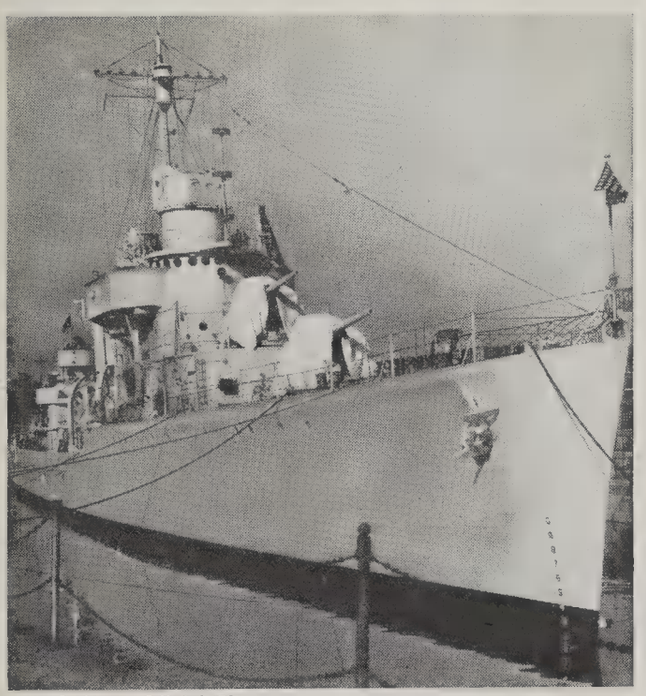
***USS Anderson, Sims* class, combines many successful features**

THE *Farraguts* differ widely in appearance from the "flush deckers" and represent a considerable improvement over them. They have a raised forecastle and only two funnels instead of the flush deck and four funnels of the older boats. They are faster and better steamers, have a much steadier gun platform, and are not so wet forward in heavy seas. These superior nautical qualities obtain in all of our modern destroyers.

In 1933-34 twenty-four destroyers were laid down. Eight of them belonged to the *Porter* class and the remainder to the *Mahan* class. The former were large, powerfully armed boats of an entirely new design, intended to operate as squadron leaders. They displace 1805 tons and mount eight 5-inch guns, at least ten smaller anti-aircraft weapons, and eight 21-inch torpedo tubes. The 5-inch guns are paired in enclosed shields, superimposed, two forward and two aft, giving these boats an appearance very similar to a light cruiser's. This resemblance is increased by the heavy tripod masts with their searchlight platforms. The torpedo tubes are grouped in fours on high revolving mounts, one between the two funnels and one between the second funnel and the mainmast. Designed speed is 37 knots, obtained by 50,000-horsepower engines. On trials 39 knots were attained without difficulty. About 600 tons of fuel oil can be carried. Each boat cost about $4,000,000 to build.

The 16 units of the *Mahan* class, all completed in 1936-37, were an enlargement of the *Farragut* design. Two of them, the *Cassin* and *Downes*, sank under Jap air bombs at Pearl Harbor, while a third, the *Shaw*, had her whole forepart demolished. With a temporary bow fitted, however, she reached a West Coast port for permanent repairs.

On displacements ranging from 1450 to 1500 tons, the *Mahans*, as compared with the *Farraguts*, carry four additional torpedo tubes and about 100 tons more fuel oil. The foremost set of tubes is on a high center-line mount between the funnels, while the remaining two sets, one on either beam, are mounted on the deck and abaft the second funnel. Originally these boats could be distinguished from the *Farraguts* by their tripod foremast, light mainmast stepped right behind the second stack, and No. 3 gun (5-inch) on the after shelter deck (instead of abaft the second funnel, as in the *Farraguts*). Recently, however, pole rig has replaced the tripods, and mainmasts have been removed from some units.



U. S. Navy Official Photo

***USS Ellyson* carries 5-inch guns**

FOURTEEN destroyers, 10 of the *Craven* class, two of the *Dunlap* class, and two of the *Somers* class, were laid down in 1935. The *Cravens* are 1500-tonners with four 5-inch guns and sixteen torpedo tubes—the heaviest torpedo armament ever fitted in a destroyer and equalled only in the 7500-ton British cruisers *Emerald* and *Enterprise*. Their two forward 5-inch guns are mounted singly in enclosed shields, while their torpedo tubes are in quadruple mounts, two on either side of the deck. Designed horsepower and speed are the same as in the *Mahan* and *Farragut*, but fuel oil capacity has been increased to 600 tons, giving a range of more than 8000 miles at 15 knots. The *Cravens* can readily be distinguished from our earlier destroyers by their single, flat-sided funnel. In 1936-37 work on 12 additional boats, differing slightly in appearance and known as the *McCall* class, was commenced. In them the freeboard amidships, between the forecastle and the foremost sets of torpedo tubes, was raised several feet in order to keep out heavy seas. One unit of the group, the *Benham*, considerably exceeded 40 knots on her trial runs, thereby smashing all speed records for American destroyers.

The *Dunlap* and *Fanning*, commissioned in 1937, are generally similar to the *Mahans*, differing from them only in having their forward 5-inch gun in enclosed shields.

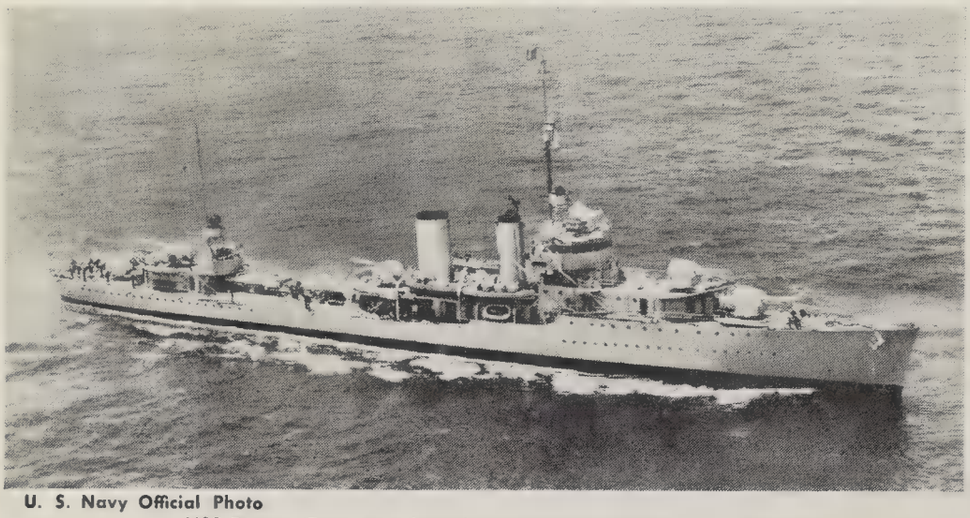
The 1850-ton *Somers* and *Warring-*

ton and three sister boats laid down in 1936 (*Sampson, Davis*, and *Jouett*) are logical developments of the *Porter* design. They have an extra set of torpedo tubes, slightly increased horsepower (52,000), a single funnel, and greatly reduced rig. Their 12 torpedo tubes, mounted quadruply on the center-line, enable them to fire the world's heaviest torpedo salvo. A pole foremast replaces the tripod of the *Porter*, while the mainmast is a mere stump, intended only as a flag-staff.

U. S. Navy Official Photo

USS Clark, Porter class: Powerfully armed, entirely new design

Twelve 1570-ton *Sims* class boats, combining the most successful features of the *Dunlap* and *McCall* designs, were begun in 1937-38. Their armament was similar to the *Dunlap's*, while in general appearance they closely resembled the *McCall*. Under service conditions, however, serious defects in stability developed. These were remedied in the earlier units by adding 60 or more tons of steel to the keel as ballast, while in later boats weight was saved by reducing the thickness of the plating for decks and superstructure. As finally completed, therefore, the *Sims* class actually displaced from 1640 to 1670 tons and carried five 5-inch guns and eight or 12 torpedo tubes. Enclosed shields were provided for guns Numbers 1, 2, and 5, and light armor protected the bridges and control positions. Features of the design were the rounded lines of the forecastle and forward superstructure, which gave these boats a distinctly streamlined appearance. They were refitted last year and given additional anti-aircraft guns, and torpedo armament was reduced to eight tubes.



U. S. Navy Official Photo

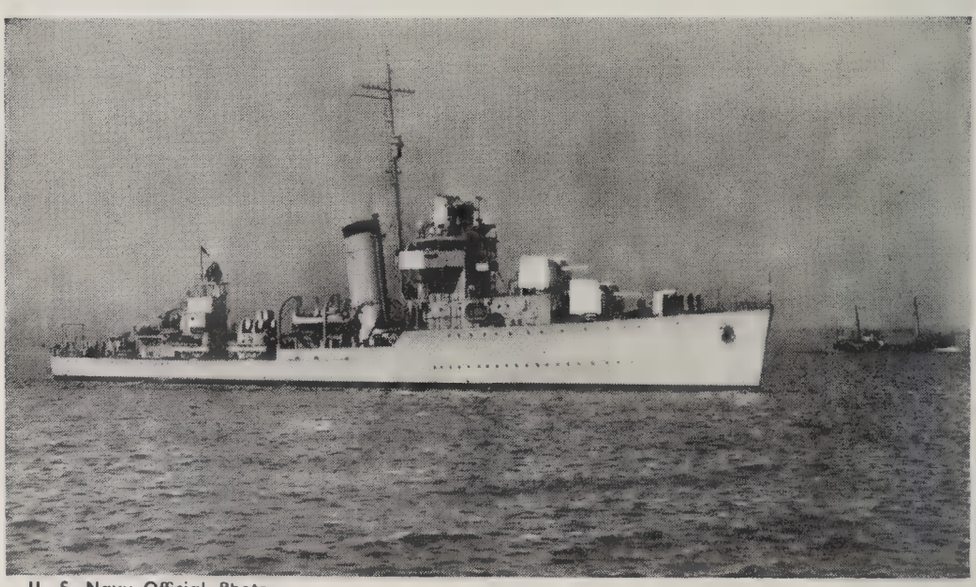
USS Dewey, Farragut class, has reported speed of 41 knots

In 1938-39 twenty-four *Benson* class destroyers, two-funneled modifications of the *Sims* design, were laid down. They were the last of 97 destroyers built under the qualitative limitations of the 1936 London Naval Treaty. All entered service in 1940-41, the *Ingraham*, last of the group, being commissioned in July, 1941. On a displacement of at least 1630 tons they carried five 5-inch guns (now being reduced to four) and eight or 10 torpedo tubes.

The 1940 program authorized the construction of 38 new destroyers. This was soon followed by a special emergency program providing for 155 additional boats. These 193 destroyers will be of three distinct types. The *Bristol* class, comprising 78 units, are 1700-ton improvements over the *Benson* design. Two of them, the *Bristol* and *Ellyson*, entered service just before we were attacked by Japan. Two others, *Emmons* and *Hambleton*, were commissioned soon afterwards. The *Bristols* carry four 5-inch guns and most of them have a torpedo armament of ten tubes, quintuply mounted.

Two 2100-ton destroyers, *Percival* and *Watson*, are listed as belonging to a "Special Type," concerning which all details are restricted. The remaining 115 new destroyers will be of the *Fletcher* class, 2100-tonners designed as "replies" to Japan's 2000-ton *Kagero* class boats, which mount six 5-inch guns and, according to some reports, eight tubes for discharging huge 24.5-inch torpedoes. No particulars concerning the *Fletchers* have been released.

The commissioning of these new destroyers should profoundly influence the course of the war at sea. Stronger anti-submarine and anti-aircraft protection can then be given to all of our convoys in the Atlantic and Pacific, while the U-boat threat off our East Coast can be greatly reduced if not entirely eliminated. The Navy Department is taking no chances, however, and since Pearl Harbor has asked for several hundred new destroyers and other escort types.



U. S. Navy Official Photo

USS Mayrant, McCall class, has higher freeboard amidships

Day After Tomorrow

How the War-Time Workings of a Variety of Industries Will be Reflected in Peace-Time Operations

A. P. PECK

(In Two Parts—Part One)

To what extent are research, development, and invention, as prompted by war-time production, being correlated with plans for civilian production in post-war days? That question expresses the essence of SCIENTIFIC AMERICAN'S industrial survey; the answers to it and other queries which would naturally arise in any ensuing discussion form the basis of the present article.

But before reporting the results of this survey in detail, it is desirable that certain things regarding it be fully understood. First, the survey itself is based entirely on the premise that the United Nations will win the war. At the time of writing and from this point of view there is no assurance that this will be the case, although an inborn faith in the ability of the United States as a nation to carry through with a given project, no matter how long it may take to complete, makes it almost impossible to think otherwise. Thus, while some may place the stamp of wishful thinking upon such a premise, the assumption that we will win the war—and then will have to win the peace—must be kept in mind when reading the following paragraphs.

Secondly, there may arise the argument that any thinking toward post-war production or post-war activities of any kind will of necessity detract just that much from the more important work of the moment—winning the war. This is necessarily a fallacious argument, since it must be based on the assumption that the human mind is a machine that can be directed at all times along a set path. Where is the business executive, the engineer, the production man, who, face to face with the shaving mirror, under the morning shower, dozing off to sleep at night, does not frequently find his mind toying more or less casually with some problem far afield from his immediate occupation? What is more natural, then, that these same men, even though engrossed with problems of war-time production, should visualize the effect that their present work will have on the future in the bright day after tomorrow when the war is over and the problems of peace-time operations once more arise?

That such visualizations will benefit the entire human race is obvious. That they can interfere in the smallest amount with the war effort is a thought that has no real basis in fact. That they can even serve to stimulate present production is an important possibility, acting, as they so frequently can, as a spur to mental and physical activity and as an incentive to get the present job done so that the war can be won and we can get back to more normal work.

Yet, despite all the things that are being done and have been accomplished for post-war operations, there are still those who feel that such planning is useless. True, the planning is all subject to change without notice and what may seem perfection today may be in the discard by tomorrow. Nevertheless, any planning, so long as it be based on sound reasoning, is better than none at all. There are many who will not agree with this. For example, there is the top executive of a huge plumbing manufacturing organization who, when asked the question in the first sentence of this article, replied: "Not at all." Then he spent an hour telling of his disapproval of many different governmental plans for many things. At least the government planning was an attempt to step forward and must be accepted as being more desirable that a "Not at all" attitude.

Mayor Fiorello H. La Guardia, of New York City, in a quoted statement, recently made himself representative of the confusion that exists in many minds regarding this matter of preparation for day after tomorrow. "Let's win this war first and discuss the after-war period later," said Mayor La Guardia. Later, but on the same occasion, he suggested that the government have a vast public works program "ready to roll into operation to prevent . . . serious dislocation after the war." How this program will grow to a point where it can be put into operation without planning is something that the Mayor did not explain.

There are, however, many outstanding industrialists who have given serious thought to the future, familiar as they are with the necessity of careful planning of all steps that involve the operation of a successful business. These same men know, also, that all plans are necessarily impermanent, that they must be laid with an eye to change, that the lessons learned from day to day may soon outmode operations that today seem basic in nature. Yet, in the light of such knowledge they are willing to voice opinions regarding the future, to place at the disposal of others their restrained optimism, their "know-how," gleaned through years of hard-won experience.

It should be noted that the basic question of this industrial survey limits it severely—and purposely—to technological developments of today which will affect our post-war world. No attempt has been made to assay or evaluate the psychological effect of World War II on the worker, to enquire into the sociological problems of the future, or to become concerned with any views of the future other than those which can be based on the practical industrial developments of the moment. Interesting though these other aspects may be, they have been purposely avoided and left to the tender mercies of other researchers. They, of course, will have their place in the future, but since experience has shown

• SITTING at an editor's desk during such times as these gives one a curious sense of detached attachment with the world of science and industry. The editor is part of it all, yet, so to speak, is on "detached service." Across his desk pour reports from all fronts—military, industrial, governmental, personnel. From these reports are sifted material for publication, leads for articles, waste paper for reclamation, all gradually working toward the finished magazine that you see each month. One of the leads so sifted resulted in the beginnings of an industrial survey upon which is based the accompanying article, compiled after personal interviews with leading industrialists, extensive correspondence, and mulling over of voluminous published material.

The present article, therefore, may be considered as a compendium of several minds, brought together and woven into one running story. All that the story tells, however, is not in the written word. Between the lines there is to be found a grim determination on the part of American industry that, come what may, the American way of free enterprise will not be relinquished without a fight, that industry will, after the war is won, demonstrate once more that it is capable of giving to the people of this nation and of the world those benefits that can be provided only under the proved system of democracy.—*The Author.* •

the vast importance of technology in the development of our industrial civilization, it seems only right that at this critical moment in history due attention should be paid to it and to the part which it will play in the coming days of peace.

THE first organization to be approached in the development of this survey was Westinghouse Electric and Manufacturing Company. This company, like many others, is so far converted to war-time production that its out-put for civilian consumption is now an almost non-existent part of operations. Yet "planning for post-war operations is very definitely a part of the Westinghouse program today," said G. H. Bucher, President of Westinghouse. "However, because the future is still obscured by clouds of war, the planning must necessarily be subject to workable flexibility. Executive meetings, held every two weeks, almost invariably involve discussions of such plans. Frequently, these plans take immediate form in a step forward in our war-time production processes; sometimes they must be shelved for the duration. And when a step is taken it may not necessarily appear to be in the direction of peace-time operations, yet it is invariably along the industrial path to future developments.

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G. H. Bucher, Westinghouse: "Our development and research programs are larger than ever before . . ."

"Probably the best way to summarize our present position as regards 'Day After Tomorrow' is to say that our development and research programs are larger than ever before. This does not involve our consumer-goods production program which, of course, has been severely curtailed in many fields to meet the increasing demands for military production.

"Because of the need for military secrecy about many of the activities of Westinghouse, it is virtually impossible to give exact statements on correlation of war-time production with possible civilian production in post-war days. We are learning many things in a wide variety of fields, however, and every assurance can be given that lessons from our war-time activities will have many applications later on."

Westinghouse is known to be engaged in the manufacture of many kinds of war apparatus that will possibly lead to new developments for peace. For example, some time ago when Army officials wanted to find means of improving the gunners' marksmanship in tanks, they came to Westinghouse with the problem. When a tank is speeding over rough ground, the gunner's task of hitting a given target may be likened to an attempt to thread a needle while galloping on horseback. Westinghouse research engineers produced fire-control equipment that resulted in considerable improvement. This fire-control equipment probably can be adapted to post-war uses, with great advantages over the peace-time mechanism that gave it birth—advantages that might never have been realized but for the impetus of war-time demands.

Another war-time development that may have wide uses in peace-time is a radio panel consisting of a layer of spun-glass cloth sandwiched between layers of fireproof, strong plastic. Westinghouse engineers developed the combination to resist the stresses that are set up on board a battleship when a broadside is fired. Under these conditions, there is a sudden compression of air in below-deck compartments—often sufficiently severe to shatter the brittle panels ordinarily used in radio and control instruments.

Use of radio communication between ships in war-time convoys is restricted, lest the signals give information to the enemy. Westinghouse illumination engineers have designed a lamp by which code signals can be transmitted in a horizontal, narrow beam not visible from altitudes that enemy aircraft must fly.

In much of the war production of Westinghouse, of which the preceding paragraphs give but a sketchy idea, engineers have had to call on all of their skill and ingenuity, particularly in making up for the loss of materials on the priority list. Substitutes have been devised for long-accepted materials and, often, substitutes have had to be devised for substitutes. In practically every case, however, the substitutes have been so efficient that in only a few applications has performance or quality suffered; frequently the changes have been for the better.

An important part of the equipment which the company has installed for war production will be available, with little or no change, for post-war operations, Mr. Bucher believes.

"An example of this is found in the manufacture of ship propulsion motors," he explained. "If the end of the war ends the demand for these motors, the same production facilities can be turned over to the manufacture of generators for peace-time use.

"In spite of all the extra engineering effort going into our work to meet war requirements, some improvement is necessarily continuing in transformers, generators, motors, and lighting equipment, as well as in household appliances and the multitude of other things, counting all the variations of each, that add up to the grand total of over 100,000 products made by Westinghouse. We feel that all of this gives assurance that, after the present world debacle is over, living standards can again resume their upward climb."

FAR different in scope from the electrical industry are those organizations devoted to the production of metals. Some of the steel producers did not feel that they could co-operate in this survey, apparently because their operations are so basic in nature that war production means simply an all-around speed-up rather than any change in principles. The aluminum industry, however, represented in this case by the Aluminum Company of America,

Dr. Francis C. Frary, Aluminum Company: "One of the most fertile fields for aluminum in the future" is in the manufacture of textiles

had much to say about the present and future.

"Right now, of course," stated Dr. Francis C. Frary, Director of Research at the Aluminum Research Laboratories, "we are confining all our efforts to the production of aluminum for military purposes. There are items, however, which were just barely under way at the time of Pearl Harbor which had to be shelved for the duration, despite their tremendous possibilities. These are the items which should be stressed, principally because they have already been proved and are not merely idle fancies that come under the head of wishful thinking.

"Wide aluminum applications in architecture are about 12 years old, yet this field has barely been touched. There were a number of dramatic installations, such as the spandrels on a number of modern skyscrapers, the use of aluminum in decorative statuary, and in molding and trim; but, on the whole, there are many applications of aluminum in architecture which need developing. One of these is the aluminum window frame for residential construction. We feel that here aluminum has a very bright future, because these frames are efficient, permanent, easy to handle, and present no problems of maintenance. The frames which have been installed in large skyscrapers in the past 12 years have given no trouble, and we feel that the same condition will prevail when aluminum window frames are adapted for home construction.

"The first aluminum streamlined train made its debut in February, 1934," continued Dr. Frary. "Since that time, about a dozen such trains have been built and are now in service. Their performance made a tremendous impression upon railroad officials, and they will no doubt be the forerunners of a great number of other aluminum trains. In addition, more aluminum will be used on freight equipment. Some very thorough tests were made with hopper cars for coal and sulfur transportation. Sulfur attacks steel rather rapidly, but has no effect on aluminum. All coal contains a certain amount of sulfur, and this chemical in the past has been a problem to railroad officials. The elimination of this problem by the use of aluminum-bodied hopper cars with aluminum facings may well be considered at the time when aluminum will be again available for civilian needs."

The sinking of hundreds of merchant ships during the past two and a half years means that there is bound to be great and continuing activity in marine construction at the conclusion of the war. The world is and will be greatly in need of ships to carry on its commerce, and the number of these ships must be adequate to take care of world trade. Aluminum long ago had been found to be a desirable metal in marine construction. The use of aluminum for entire superstructures, boats, davits, fittings, bulkheads for passenger quarters, and for numerous other applications allows a redistribution of weight in such a manner that the ship will function as a more efficient unit. It will either be lightened to such an extent that smaller engines will be needed to propel the boat at a given speed, thus saving fuel costs; or, with the same type of engines as formerly used, the boat, being so much lighter, can be propelled faster and reach its destination sooner, thus saving time.

Life boats also hold interest as a future development. As far as is known, there are about 70 all-aluminum life boats in service at the present time. A number of these are on European ships; the United Fruit Company has had a number of aluminum life boats in service for several years and is quite enthusiastic about them. The *Nieuw Amsterdam,* flagship of the Holland-America Line placed in service about 1937, had 22 aluminum life boats. Aluminum life boats are not only free from maintenance troubles, but they also serve to lessen the weight of the ship at a point where weight is not desirable; namely, near the top deck. The lesser weight, therefore, increases the stability of the ship, and is more practical, according to Dr. Frary.

"Aluminum has been used in the textile field for some time," continued Dr. Frary, "but its applications there can be widely increased. In our opinion it is one of the most fertile fields for aluminum in the immediate future, particularly since rayon and nylon are enjoying an ever-increasing popularity. Aluminum is widely used in the manufacture of these textiles."

The art of brazing aluminum has been developed to a commercial degree within the past year or so. Unfortunately, activities in aluminum brazing have had to be heavily curtailed because of the war effort, but this will no doubt be a method of joining aluminum to be seriously considered in the future.

Mr. John O. Chesley, Manager of the Development Division of the Aluminum Company of America, had this to say: "The aluminum beer barrel had a very interesting history, and we feel confident that it will be in great demand when aluminum is again available for civilian purposes. The beer barrel got under way very slowly at first, but it was found to be so excellent a package for beer that brewers had begun to buy it in large quantities when the metal was withdrawn from the civilian market. A typical aluminum half-barrel weighs only 18

John O. Chesley, Aluminum: "Just to show that we are trying not to miss any bets in the world to come . . ."

pounds, whereas a wooden barrel of the same dimension weighs 65 pounds. The aluminum barrel does not have to be pitched, since aluminum does not affect the taste, odor, color, clarity, or limpidity of beer. There are no maintenance problems to speak of with the aluminum barrel. All these advantages combined to make this barrel a very desirable commodity.

"Just to show that we are trying not to miss any bets in the aluminum world to come, we might cite one commodity which was ready for marketing when the war broke out and priorities put a stop to this type of product. That is the aluminum plate used by artists for making etchings and dry-points. Copper had been the traditional medium for more than 400 years, but copper had certain disadvantages which have been overcome by a special aluminum plate. In the case of copper, an artist could only make about 75 good prints from an etched plate before the plate would begin to break down. He could only make about 15 good prints from a dry-point. In aluminum, an edition of 250 prints is generally possible, and in many cases, the edition far exceeds this figure. This holds for both etchings and dry-points on aluminum. The metal, furthermore, is light in color and, therefore, easy on the eyes. It has only one disadvantage: once a line is cut, this line cannot be eradicated

by the methods used with copper. The line is there to stay and cannot be changed."

Add to all this the new know-how in aluminum manufacture and fabrication that is being acquired, the development of centrifugal casting of the light metal, the possibilities of aluminization of steel to replace tin plate, and so on, and it becomes obvious that the civilian of the future will think of more than pots and pans when aluminum is mentioned.

WELDING of metals of all kinds has come so rapidly to the fore in so many war-production operations that Mr. James F. Lincoln, President of the Lincoln Electric Company, was consulted regarding his views of the future. "The problems which I believe we are going to meet after this war is over," said Mr. Lincoln, "are two-fold:

"First of all, there will be great unemployment because even if the call for goods after the war is so great to keep all men employed, the reshuffling of these men from the war industries to peace-time work will take some time. We are, therefore, planning on cushioning this shock to these men by present-day savings.

"The second thing that will occur is that competition will have changed to a very great extent due to the existence of a great many government financed organizations which will have much less overhead than those who have financed their own expansions.

"Because of those two things it is our policy," continued Mr. Lincoln, "to now develop the new machinery or present-day production methods which will be more efficient and which can be used in the post-war period, and to get now the higher efficiencies from this machinery and, therefore, the lower cost. It is our policy also to develop the end product to the maximum degree possible under present conditions.

"We are in the very fortunate situation of having a product which now is the same as it was before; the war effort is not changing the character of our product, so that the development of the product and the manufacture of it is continuing for the war effort just as it will for the peace-time effort after the war is over.

"Therefore, we are also bending our energies toward a reduction in cost of the application of the process, and to the elimination of a great many of the abuses which now exist because of ignorance in the field about the application of the process, so that the actual cost of doing the work will be cut to a minimum.

James F. Lincoln, Lincoln Electric Company: "There is nothing that can keep us from hoping, which is also part of our post-war program"

"Of course," concluded Mr. Lincoln, "there are a great many unknown features facing us. For instance, there is no way of knowing what kind of government we will have when this is over. It is rather obvious from previous history that it will be totalitarian. No bankrupt nation ever escaped totalitarianism. Under those conditions perhaps all of our planning will go for naught because we will be told by bureaucrats what to do and how to do it, but there is nothing that can keep us from still hoping, which is also part of our post-war program."

DESPITE the somewhat pessimistic note on which Mr. Lincoln ends his contribution to this survey, it is obvious from even the few views expressed here that American industry is fully alive to the responsibilities which it faces in the day after tomorrow. In our next issue will be continued our report on the unearthing of these encouraging views.

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CORK SUBSTITUTE

Found in Product of Sugar Cane

SUGAR cane from Louisiana has been called upon to take the place of cork from war-encircled Spain to help protect the nation's supply of perishable foodstuffs. From the fibers remaining after the sugar juices have been squeezed from the cane stalks, a new kind of cold-storage insulation has been developed by The Celotex Corporation. Its ability to keep out heat is said to be equal to corkboard's. It is cheaper, stronger, and the supply of raw material far exceeds all possible needs of the United States and its allies.

More than a year ago, as the war gradually strangled the flow of cork bark from Spain's trees to industry in the United States, research men began seeking a satisfactory substitute for corkboard insulation. In the Celotex company's big plant and research laboratories at Marrero, Louisiana, across the Mississippi from New Orleans, they developed a product with all of cork's useful insulating qualities.

To match cork's ability to slow down the passage of heat, the research men mixed the cane fibers in selected lengths and thicknesses, then wove and felted them into half-inch insulating boards of a low density.

To equal cork's resistance to moisture, the individual fibers, before being felted into boards, are sterilized, waterproofed, and then protected from dry rot and fungus growths by the patented Ferox process.

To provide further resistance against moisture, the half-inch boards are laminated together with weather-resistant special asphalts between layers. An additional coating of asphalt is then applied to the outer surfaces. Thus, a two-inch thickness of insulation has five moisture-resistant asphalt membranes, one on each outer surface and three between the boards.

WAR PLANTS

Being Built of Wood and Concrete

TWO new buildings for the manufacture of airplane engines under mass-production conditions have recently been announced as being designed to make use of readily available material and to conserve steel for other war purposes.

One of these new plants is being erected "somewhere in Michigan," the other "somewhere in New Jersey." The first, being built by Continental Aviation & Engineering Corporation and designed by the Russell Engineering Corporation, is being built of wood and other substitutes for critical materials throughout. Exterior walls and piers will be of brick, and interior columns, trusses, and sash will be of wood. Mass concrete footings without reinforcement will be used.

The main building, the largest wood-truss structure built in Michigan in many years, will be of one-story construction, except for a mezzanine 40 feet deep across the front, housing the drafting room. Offices will occupy the

space below the mezzanine and will be 80 feet in depth.

The New Jersey plant of the Wright Aeronautical Corporation is being constructed of concrete by what is known as the "warspeed" process. It is claimed, that, using this process, factories can not only be built more rapidly than of wood or steel, but that, in the construction of a building with 2,000,000 square feet of floor space, there is a saving of enough steel to build a Navy cruiser.

This concrete building, designed by the Wright company in co-operation with Albert Kahn, architect, is literally being built from the roof down, the floors and walls being the final units to be completed. The building is a single-story structure with reinforced concrete columns and roof and unreinforced concrete floor. The design is such that the building may be easily camouflaged and is well suited to production-line operations.

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GLUED—Spars for new minesweepers being constructed for the United States Navy are hand-turned of selected spruce and are glued with a synthetic resin glue.

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GLASS BEARINGS

Replace Sapphires For Use In Instruments

SYNTHETIC sapphires, used for years as pivot bearings in small electric meters, are now virtually unobtainable from Switzerland, former main source of supply. Hence there has been developed in the General Electric Laboratories a new type of high-alumina content glass which can be hot-formed into tiny bearings which satisfactorily replace the synthetic sapphires. Engineers say that, from a performance standpoint, there is little to choose between the new glass jewel and the sapphire for small instrument applications.

FIRE HOSE

Now Made With Minimum of Rubber

WHEN a War Production Board order, earlier this year, cut the amount of new rubber which could be used in fire hose from about 17 to a maximum of seven pounds per hundred feet in the 2½-inch size, and correspondingly in other sizes, it had the immediate effect of making it impossible for manufacturers to supply hose meeting the standard of Underwriters' Laboratories and the specifications under which thousands of cities have been ordering such hose.

To help remedy this situation, Underwriters' Laboratories, after considerable experimentation and research, developed an emergency alternate specification for fire hose and manufacturers are now supplying hose built to the new specifications.

This new hose will handle equally as well as hose meeting Underwriters' Laboratories' regular specifications, the main difference between the new and the old hose being that the new hose will probably not last as long. Otherwise the performance characteristics remain much the same.

HARD RUBBER

Will Stand Relatively High Temperatures

DEVELOPMENT by its research laboratories of a superior type of hard rubber made from Ameripol, the synthetic rubber which its chemists created, is announced by The B. F. Goodrich

Synthetic: extruded, molded

Company. According to a report just issued, the new synthetic hard rubber, before softening, will stand temperatures 100 degrees, Farenheit, higher than the best hard rubber made from natural crude. It is expected that the new development will extend the field of hard rubber, since it overcomes many of the limitations which had restricted the service of this type of rubber under extremely severe conditions.

LACQUER CONTAINERS

Protected by Addition of Organic Chemical

THE tendency of clear lacquers, alcoholic shellacs, and nitrocellulose solutions to corrode plain steel containers can be overcome by the addition of small quantities of a new organic chemical. This suggests interesting possibilities for lacquer packaging during the current limitations on tin supplies. Because of the relatively low cost of the new chemical, it is believed that its use may continue after the tin shortage is relieved.

The chemical, it is explained, reacts with the metal surface of the container to form an insoluble film, which, though of microscopic thickness, is sufficient to afford the necessary protection. Because of the nature of its formation, the film is self-mending in case of breaks. In normal clear lacquers, about one-half ounce of the chemical per gallon of lacquer is sufficient to produce the desired effect.

SILVER USES

Being Increased in Electrical Equipment

JUST as Pizarro, conqueror of Peru, once shod his horses with silver in an emergency, engineers are now using the precious metal instead of tin, copper, and other scarce materials in electrical apparatus.

There is at least a little silver now, according to Harry A. Winne, Vice President of General Electric Company, in almost every motor, generator, transformer, or other piece of apparatus made by the company for the war.

"In many cases the use of silver adds to the cost, a consideration secondary to production at the moment," explains Mr. Winne, who is in charge of apparatus design engineering. "In such instances, its use is probably temporary.

"On the other hand, the use of silver in current-carrying contacts and in brazing alloys frequently results in an improvement in quality sufficient to justify the greater cost, and so for these purposes its use will not only continue after the war but probably will increase."

Silver is replacing tin in soft solders, alloys which require comparatively low temperatures in joining metals. In the past, these alloys have had a relatively high tin content, ranging from almost pure tin to a very common composition of 40 percent tin and 60 percent lead. Today, however, solders in wide use range from 20 percent tin, 1 percent silver and 79 percent lead, to 97.50 percent lead and 2.50 percent silver.

Substitutions of silver for copper are being made in brazing alloys, which require high temperatures for joining metals. One type of brazing alloy, widely used before the war, was

composed mainly of copper, the remainder being silver and phosphorus. Now alloys with copper content as low as 16 percent are in general use. A typical alloy consists of 50 percent silver, 16 percent zinc, 18 percent cadmium, and only 16 percent copper.

Aside from saving tin by reducing the tin content of solders, brazing technique is now widely replacing soft soldering to conserve tin and copper. Brazing also, chiefly because of the silver present, is often quicker, more reliable, and produces stronger joints.

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LAMPS—The ordinary small Westinghouse Mazda lamp owes much of its lighting efficiency to the exactness of the diameter of its tungsten filament wire. This wire is so thin it is measured by weighing it on scales accurate to within 40 billionths of a pound. These scales are sensitive enough to weigh a penciled signature.

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FREEZING

Of Machine-Tool Parts Has Many Advantages

OF INTEREST and importance to science, industry, and business is the development and perfection of the new Deepfreeze Santocel extreme low temperature metal chiller, manufactured by Motor Products Corporation.

Among the numerous applications of the metal chiller, made in portable form for ease and economy in use, is contraction in compound fitting of metal parts. This facilitates slide fits in assembly operation, relieves strain and possible fractures. Exhaustive tests by competent authorities also indicate that sub-zero tempering and stabilization of high-speed tool steel will produce a combination of hardening, strength, and ductility unobtainable by ordinary hardening or tempering. Therefore, the freezing system should have extensive use in the aircraft industry and by machinery builders, tool makers, automotive manufacturers, and so on.

In one of our illustrations is shown a freezing installation in a large machine-tool plant doing extensive war work. The operator is inserting a machine-tool spindle in the unit. This is done so that costly anti-friction precision bearings can be assembled easily and permanently without damage. This is of particular importance today because machine-tool manufacturers have been forced to employ some unskilled help; in assembling bearings with a drive-fit to shafts, care must be taken not to damage the bearing which is both costly and difficult to replace.

The bearing shoulder of the shaft shown is approximately two inches in diameter and can be shrunk .001 to .0015 of an inch in 40 minutes at 50 degrees below zero.

Another use for the portable unit in this large machine-tool plant is shrinking steel sleeve type bearings used in cast-iron fixture housings for supporting and guiding precision boring

Freezing a spindle

spindles for airplane boring machines. The bearings are usually made .0005 of an inch oversize, or are longer than the bore in the cast-iron housing. The bearings are frozen to shrink sufficiently so that they can be placed in the housing with ease. When room temperature is again reached, the bearings will have expanded to an accurate and tight fit.

LEAD BEARINGS

May Prove to be Superior to Tin Alloys

A WAY to meet the tin shortage as it threatens one of the most important applications of this highly strategic metal is being investigated by engineers who believe they have now found ways to produce alloys of lead to take the place of tin alloys in bearings.

One of the most gruelling trials of these new lead alloys for bearings is being conducted at The Cooper-Bessemer Corporation, according to Ralph Boyer, chief engineer.

"Alloys with lead as the base metal have been put into bearings of the corporation's Diesel engines and air compressors, and from all indications they are doing very well," the engineer said. "About a year of testing will be required, however, to prove conclusively that lead is an adequate substitute. We have run our tests for the last several weeks.

"We have been forced to turn to lead as a base metal in place of tin, and now there is every indication that lead will produce better bearings than we have ever had before."

The present importance of tin in this application is brought out by the fact that bearings in every automobile being driven in the United States contain on an average about 7½ pounds of this metal, the bearings containing between 88 and 90 percent tin.

SUPERSEDED

Riveting Machines Replaced by New Welders

EVIDENCE of how rapidly production techniques on war jobs are changing is given in the story of the giant riveters, only a year old, which soon will have outlived their usefulness in tank work.

Developed and built last year by one automotive company for its tank job, these giant machines are being laid aside because of the Army's recent decision to switch from the riveted to the all-welded tank.

To employ in tank production the cold-riveting process that had previously proved successful in automobile-body riveting, this company designed huge horseshoe-shaped riveters to do the job. Some stationary and others brought into position by overhead cranes, these machines exerted as much as 100 tons of pressure in squeezing rivets into place.

Frictional heat induced by this tremendous pressure expanded the nickel steel rivets and improved their strength, whereas in the previous method of heating and hammering, some of these qualities were lost.

This method was so successful that more than 95 percent of the rivets used in the tank hull were inserted by cold riveting. Hot rivets were used only in the tight spots that would not allow entry of the large machines.

Yet, experience gained from major tank battles such as took place in the Libyan desert last year prompted Army officials to switch from the riveted to all-welded tanks. One of the major advantages of the new model tank will be the ability of the all-welded hull's curved surfaces to deflect projectiles more readily.

Thus the giant riveters, which cost thousands of dollars to build, must be laid aside. They will, however, be made available for other war work.—*Automotive War Production.*

INDUSTRIAL TRENDS

TOWARD BETTER NUTRITION

THE food that people all over the world eat, and the important industries which produce that food and make it available to the general public, are, without a doubt, going to be greatly and favorably influenced by a development that is largely an outgrowth of the present war. This development, the dehydration of a large variety of foods, was dealt with in its technical aspects in our issue of July, 1942. In even the short space of time that has elapsed since that article appeared, the industry has advanced measurably in its endeavor to provide greater quantities and a wider variety of foods than ever before.

When you think of dehydrated foods, don't think of them as being in the class of dried peas and beans, prunes, and similar staples of long familiarity. The dehydrated foods of today are as different from these old standbys as jerked beef is from a fine porterhouse. Not only are they different in their advantages but also in their qualities that show up in the final test of eating. Obviously, the main points that are aimed at in dehydration are the elimination of bulk and weight, the retention of all possible food values, and reduction of spoilage. In the older methods of drying foods, only some 50 percent of the water was driven out and spoilage was merely retarded; by modern methods it is possible to eliminate as high as 90 percent of the water or more and to so arrest the factors which induce spoilage that the foods so processed can be kept under almost any climatic conditions for months.

Our former article on this same subject told of cabbages that were dehydrated and compressed to small disks which, upon soaking and heating, resumed the appearance of the original, with all the aroma and flavor so appealing to the healthy appetite; of carrots, peas, and beans about which the same thing can be said. By now the list has been expanded to include almost every vegetable and fruit in common demand, plus eggs, butter, some meats, and even clams and oysters.

Some processes of producing modern dehydrated foods depend on dividing the food into small particles and submitting these to heat and controlled atmospheres by one means or another. Thus the natural moisture in the cells of the foods is quickly and almost completely driven off, yet the cellular structure of the materials is not affected. Herein seems to lie the secret of retaining the food value and flavor so highly important to the ultimate consumer. It appears that the rapidity of driving out the moisture also seals in those elements in the foods that furnish such factors as vitamins and essential oils, and excludes the bacteria which contribute to spoilage.

All this is not quite so simple as it may seem, yet to date many of the problems involved have been solved. Each species of fruit and vegetable requires different handling during the drying process, and even different methods of applying the heat to obtain the best result. In some cases the finely divided material is placed on trays in ovens, in others it is applied to the outside of heated revolving drums. Some foods dehydrate best when they are placed in small trays that, hooked together like a train of cars, are hauled through hot tunnels.

So much for the technical side of the increasingly important dehydrated food situation; what about the industrial side? It took the war to bring the industry to its feet and start it ahead. Our armed forces require tremendous quantities of food, quantities which, in many cases, have to be shipped long distances with assurance that they will reach their destination without spoiling. Weight and bulk, also, have to be reduced to a minimum to conserve valuable cargo space. Into this niche fell dehydrated foods. They fulfilled every physical requirement in a highly satisfactory manner.

Despite all the advantages that dehydrated foods offer, the industry itself is still relatively small, largely because it lacked public acceptance until the circumstance of war forced recognition of it. Thus, at the time of writing, there are reported to be only 25 active producers of dehydrated foods of all kinds on a commercial scale although it is said that 132 concerns are in the process of getting ready for production. Membership in the National Dehydrators Association is now 40 as compared with only 12 in January, 1942. Then, too, there are the concerns which are now producing or planning to produce the equipment used by the dehydrators, container and packaging manufacturers, and the various suppliers, all of whom form a necessary part of the whole industrial picture.

It is impossible to be too definite today about production figures of any type, yet it can be revealed that total business in the dehydrating field was only $10,000,000 in 1941. In 1942 it is estimated that this will increase 10-fold and that 1943 will see still greater increases.

What this means for the future is not difficult to visualize. After the industry has served the armed forces through to the days of peace, its products will be used to feed the millions in devastated countries, its methods will be applied to smooth out the peaks and valleys of crop production throughout the world, and it will contribute largely to the abolition of the under-nourishment that is so prevalent in this country and abroad. This means of preserving foods, now being brought to a fine point of perfection, will indeed be the basis of an industry that can go far to remove the blight of hunger from every land and to solve many of the problems that have faced every phase of the food industry in the past.

WHAT ABOUT THE AIRLINES?

RECENT announcement by the War Department that the airlines of the United States will continue under private ownership settles, for the time being, an important question about our air-transport industry. As is well known, of course, many passenger transport planes have been taken over for military use, leaving the airlines as a whole with only sufficient equipment with which, when operated on a faster turn-around basis, to continue operations on an air-milage reduction of 45 percent.

What, then, is the trend of an industry that is so important to business travel, yet is of even greater importance from the standpoint of military operations both here and abroad? Present indications are that the airlines may regain some of their equipment. This will become possible as plane production for military purposes steps up still further and current demands are satisfied. With more planes available, it is entirely possible that schedules on commercial lines may be restored to their previous condition, or even expanded to greater proportions than ever before. When this comes about, the airlines, with knowledge recently gained of improved maintenance procedure, and efficient utilization of equipment, will be in a better position than ever to provide the fastest possible means of transportation to all of our industrial fronts.

—The Editors

Cometary Tails

Added Light on an Old Perplexity: The Force Which Drives the Gases from the Nuclei

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

A FEW months ago (January 1942) we had occasion to speak of some recent results which had been derived by the spectroscopic study of molecules in astronomical bodies—comets among them. Some of the problems which were then puzzling have since been cleared up, and the story is worth telling.

First, as regards the composition of cometary gases: Dr. Swings, the Belgian astrophysicist now at the Yerkes Observatory, has identified three emission lines in cometary spectra, at 4231, 4238, and 4254, with strong lines in the principal band of the ionized molecule CH^+, which was detected last year in interstellar space. Some fainter lines in the ultra-violet are probably due to another ionized molecule, OH^+, while good arguments can be advanced for attributing the fairly conspicuous unidentified lines near 4050 to NH^+. This last interpretation can be verified only by production of the spectrum of this molecule in the laboratory—which presents a challenge to experimenters that, in normal times, would not long go without notice.

The list of molecules so far observed spectroscopically in comets looks very queer to the student of chemistry. It includes CH, NH, OH, CN, C_2, and also CH^+, CO^+, N_2^+, and probably OH^+ and NH^+. None of these ten "molecules" is what the chemist would ordinarily call by that name. They are all fragments of molecules of the familiar kind and in an ordinary book on chemistry the first five would be called "free radicals" and the others "ions." In the laboratory, they are all "unsaturated"—eager to combine with anything available that comes near, and so form stable molecules of the common sort.

Dr. Swings points out that, though they are not chemically stable in the sense that they can persist in an environment full of other molecules and atoms, they are physically stable—that is, they have no tendency to break up of their own accord into separate atoms. On the contrary, the atoms which compose them are firmly bound together. They are still very ready to pick up other atoms or molecules—if they get a chance. But the gaseous parts of a comet are of such exceedingly low density that collisions of one molecule with another must be almost completely absent. The unsaturated molecules remain as they are, not because they won't combine with others, but because they don't get a chance.

THERE may be plenty of molecules of the familiar types, such as H_2O, CH_4, and NH_3, on comets, but we could not detect them if they were there, for the spectral bands which they would emit lie well out in the ultra-violet and are hopelessly concealed from us by the opacity of the Earth's atmosphere for such short wavelengths.

In fact, it appears necessary to assume the existence of these familiar gases in comets in order to explain that of the observed molecular fragments. The latter, as Swings points out, cannot exist in the solid particles which compose the main portion of the comet. If these particles are heated, when they come near the Sun, occluded gases may escape from them; but these will have saturated molecules of the familiar kind. Something else is needed to break them up, and this is almost certainly shortwave ultra-violet light emitted by the Sun. In many cases the absorption of such light may raise a molecule into an unstable state which automatically breaks in two. The fragments sometimes fly apart at high velocities with energy derived from the absorbed light.

Swings uses this to explain the long-known and perplexing phenomenon that the gases which form a comet's head sometimes escape from the nucleus with high velocity. No pressure sufficient to produce such speeds could conceivably occur in so rarefied a medium, but dissociation of the sort just described would account for it fully. The effect might be expected to be different for different molecules. In fact, CN is driven to a considerable distance from the nucleus, while CO^+ stays close to it until light-pressure drives it off into the tail. This suggests that the dissociation process which forms the first is much more violent than for the second.

Once formed, these fragments find themselves in a region of such low density that they have very little chance of meeting any others. They are exposed only to the stream of radiation from the Sun, which fills all interplanetary space in its vicinity. If the molecules were capable of further dissociation by such radiation, it would not last long; but a molecule which escapes further breaking up may nevertheless absorb sunlight, get into a state loaded with energy and emit this again either as light of exactly the same wavelength, or as a closely associated line in the same band. This resonance process does not wear out the molecule and may be repeated indefinitely. There has been little doubt that the emission lines in cometary spectra are produced in this way; and now Swings presents a very conclusive proof. The emission of any particular bright line—say in one of the cyanogen bands—by gas in a comet means that cyanogen molecules had absorbed from sunlight, but a minute fraction of a second earlier, either this line or the closely associated one. The amount of light thus abstracted from the Sun, though enough to make the comet visible or even conspicuous on a dark sky, is too small to produce perceptible dark lines in the solar spectrum if the comet should pass between us and the Sun (as Halley's comet did in 1910).

NOW these lines of the cyanogen band fall in a region of the solar spectrum which is full of wide and strong dark lines—produced by absorption in the Sun's atmosphere by iron and other elements. A cyanogen molecule in a given state of rotation has two absorption lines. If both of these fall within wide dark solar lines, very little energy will be fed into this particular molecular state from the sunlight, and the corresponding emission lines in the comet's spectrum will be faint. But if one or both of the absorption lines fall in bright regions of the solar spectrum, the

emission lines from this state will be strong. In this way it is found that the apparent division of the cyanogen bands into two parts, one emitted by very slowly rotating molecules and another by those rotating much faster (of which we spoke last January) can be explained by the fact that molecules rotating at intermediate rates have their absorption lines falling on wide dark lines in the solar spectrum, while the others do not (at least to the same degree). The hypothesis that there are really two groups of molecules, one rotating fast and one slow, can now be abandoned.

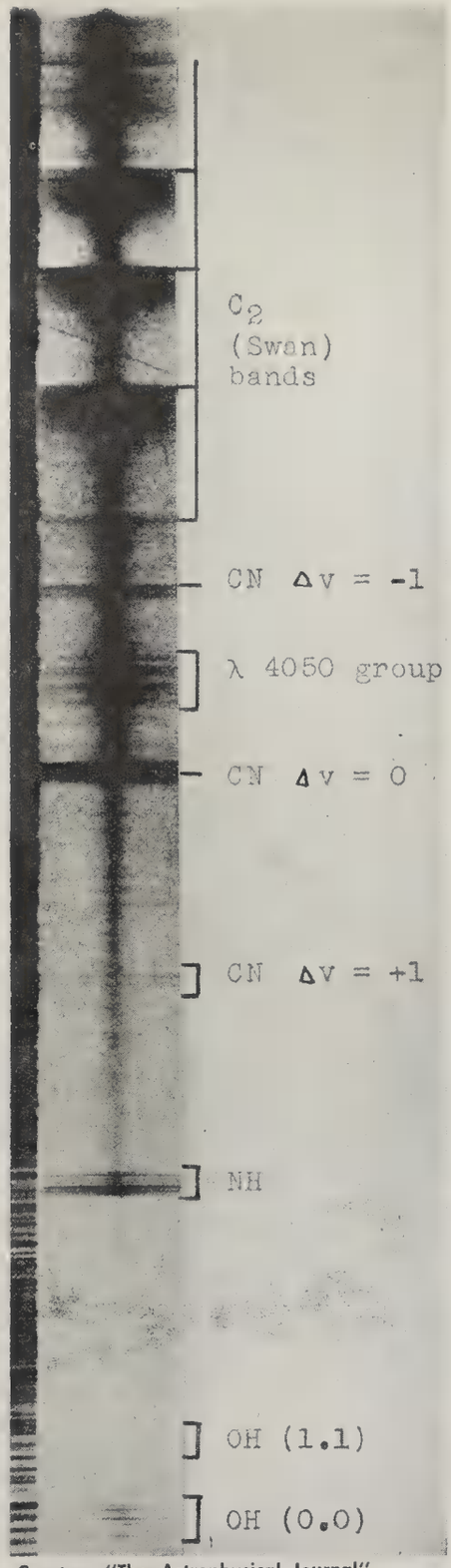
Just what the average rate of rotation of a molecule—and hence the temperature of the cometary gas—may be is harder than ever to determine, but it is little, if any, above 300° K—that is, "room temperature."

When a comet is rapidly approaching the Sun, or receding from it, the positions of its absorption lines are shifted relative to the solar spectrum. In some cases this changes the intensity of the sunlight available to excite the resonance lines. Differences have been observed in the intensities of details of the cyanogen bands in different comets which are fully explained by this. No more satisfactory proof that the radiation of comets is excited by the absorption of light from the Sun could be desired.

BAND-SPECTRA, as is well known, enable us to distinguish between the different isotopes of the same element. Carbon, for example, has an abundant isotope of mass 12 and a rarer one of mass 13. The molecule $C^{12}C^{12}$ is responsible for very strong bands in comets. Three bands of $C^{12}C^{13}$ lie clear of these stronger ones, and have been observed, though faint. The heavier isotope is therefore the less abundant in comets, as it is on earth and in the red carbon stars.

These carbon bands do not show the remarkable gaps, or faint regions, which the cyanogen bands do. They fall in a region where the solar spectrum has only weak lines (compared with the ultra-violet where the cyanogen bands lie) so that this is as might be expected. It appears, however, that the faint bands of OH^+, which fall in a region full of strong solar lines, are subject to irregularities of intensity.

All the cometary gases which have so far been observed are coniposed of four elements—hydrogen, carbon, nitrogen, and oxygen. In some comets which have come near the Sun, and been more strongly heated, the sodium lines have appeared. One of the tragedies of spectroscopy is that the great Comet of 1882 appeared before modern methods of photographing the spectrum existed. It came within a million miles of the Sun, and must have been hot enough to volatilize anything. Its spectrum at that time was examined by one or two visual observers, and seen to be full of bright lines, but no more is known. It was bright enough to have been observable with the most powerful spectographs. Ten minutes with a modern instrument might have given us information for which we may now have to wait till this comet returns, after some 600 years. Most of the other



Courtesy "The Astrophysical Journal"
Comet band spectrum, 3000—6400

elements which are known to be abundant in the Sun and stars have a very poor chance, if any of showing up in the spectra of comets at ordinary distances from the Sun. The metals and their silicates are not vaporized or even melted. Helium and neon are very abundant, but their resonance lines are in the extreme ultra-violet and unobservable. It is probable that their atoms, if present near a comet, would be subject to very little light-pressure, as the solar spectrum is weak in these regions, so that they would not go into the tail, though they would diffuse away into space from the head.

Sulfur forms compounds which, like those of oxygen, have bands in the accessible region of the spectrum. When these have been well enough observed in the laboratory, it would be interesting to look for them in comets, though they might be very faint.

IT is hardly practicable at present even to estimate the quantitative abundance of the elements in the cometary gases. Apart from the question of the intensity of the solar spectrum in the region where absorption occurs, we would need to know the absolute absorbing power of the molecule for each line before we could calculate how strong they ought to look. An interesting example of this is found in interstellar absorption. The lines of neutral iron, recently detected, are even fainter than the strongest line of neutral calcium. But it is known that the absorbing power of a calcium atom for this line is very much greater than for all the other lines put together, which it absorbs when in its normal state. For iron, however, laboratory measures show that the absorbing power for the observable lines is less than two percent, on the same scale. As regards detection by interstellar lines, iron is therefore at a disadvantage of 50 to one, compared with calcium. Not much is yet known about the absorbing powers of molecules, but there is good reason to believe that it is much greater for the CN molecule than for OH—at least, for the observable bands. The fact that the hydroxyl bands are weak in comet-spectra compared with the cyanogen bands does not prove that cyanogen is more abundant.

A great deal of very interesting, and probably remunerative work remains to be done on the spectra of comets. Unfortunately, it is only for a small part of the time that comets bright enough to be observable with high dispersion are visible.

Refrigeration For Insanity

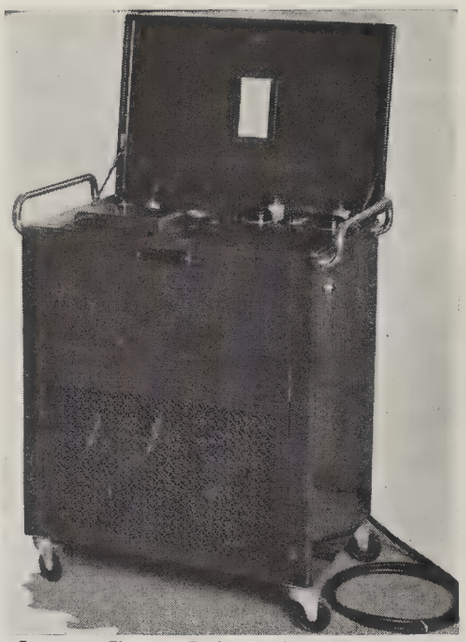
Hibernation at Lowered Temperatures Promises Value as a Treatment . . . Delayed by the War

BARCLAY MOON NEWMAN

THE most promising of all the researches that have been undertaken in the clinics that use refrigeration of the whole body as a medical measure has, unfortunately, been temporarily postponed by the war. For the first time this new therapy, popularly known as human hibernation and technically as hypothermia, has apparently found a definite, valuable application—in treating insanity, particularly schizophrenia or dementia praecox. Results in the cases studied have been remarkable, so that more extensive investigation of the possibilities and limitations of this treatment will surely be forthcoming at the war's end, if not before.

Decidedly a milder and less risky procedure than insulin shock, a treatment for insanity that was developed several years ago, hypothermia gives evidence of being more effective. Cases that did not respond to shock therapy have been markedly benefited by the hibernation treatment.

The modern psychiatrist already has been able to prove a great point: that mental illness need no longer be regarded as hopeless. Succeeding to an inspiring degree where centuries of effort went for nought, the new psychiatry has improved the mental conditions of thousands, and has effected some actual cures. Through insulin or metrazol shock, many schizophrenics have been restored to a practically normal state—though, too, there have been many failures and relapses. Hope for restoration under these treatments is generally limited to the first years of illness, presumably before the course of the disease has brought about irreparable degeneration and actual structural changes in the brain. On the other hand, there have been too many accidents—fractured vertebrae—during the violent convulsions occasioned by the treatment. Both insulin and the other commonly used drug, metrazol, notoriously often damage the brain tissue—though the very effectiveness of the treatment may be the result of structural changes that cut the activity of overactive centers. To many psychiatrists this is a dubious procedure. Dubious for a similar reason is the actual removal of cores of tissue from the brain, an operation now being tried here and there in "hopeless" cases and overenthusiastically described in popular articles despite the protests of the American Medical Association. Insulin or metrazol shock for schizophrenia, and fever therapy for brain syphilis, have nevertheless more advantages than disadvantages, and have justifiably been established in medicine. If, however, discovery of equally effective but milder, safer therapy can be made . . . .



Courtesy Therm-o-Right Products Co.
Instead of a bed of cracked ice a thermostatically controlled electric refrigerator may be used

So ran the train of thought in the minds of two Harvard Medical School psychiatrists, John H. Talbott and Kenneth J. Tillotson. Well up the temperature scale, Talbott had made important researches on heat cramps and the scientific evaluation of the ill effects of heat upon workmen. He and Tillotson, like every alert medical scientist, had been struck by the recent bold venture of Dr. Temple Fay into the strange world of refrigerated life in the treatment of cancer. Though beneficial in a limited number of cases, human hibernation as a treatment for this disease was not winning extensive application. Obviously, judgment of its value in cancer must await decades of further study. Also, just as with insulin shock and with metrazol therapy, both of which were first used on drug addicts, human hibernation could be applied in the treatment of morphine fiends. A few addicts painlessly hibernated through the first, usually dreadful, days of deprivation of their narcotics. Here, again, some additional alteration in the nervous system is induced by the treatment. The addict loses his craving, at least for a long period after refrigeration. Similarly, in tests with cancer patients who were suffering intense pain, a mysterious nervous change is brought about by hypothermia. Though no drug is administered, the patient often is free of all pain, sometimes for months after the stay of a few days in cold storage.

Talbott and Tillotson looked up the published records of Fay and his Temple University associate, Lawrence W. Smith, professor of pathology, who summarized the effects of prolonged hypothermia on normal tissues, including brain cells, as follows:

"Only rarely are significant structural changes observed in normal tissues even when subjected to prolonged local refrigeration for as much as five and one half months. Under general refrigeration such changes as do occur are insignificant."

HYPOTHERMIA, concluded Talbott and Tillotson, acts like an anesthetic and does not shock the patient as do large amounts of insulin or metrazol. Like insulin and metrazol, hypothermia is associated with a significant alteration of the internal environment of the tissues. We have become accustomed in recent years to thinking of the treatment of mental disorders in terms of procedures which produce profound alteration of the internal environment of the body. But insulin and metrazol cause demonstrable structural changes and perhaps irreparable damage. Hypothermia does not cause such damage or any demonstrable change in the structure of brain cells.

The two psychiatrists, aided by a generous grant from the Lucius N. Littauer Foundation, carefully learned the medical intricacies of general refrigeration and turned for facilities to the medical research laboratory of the Massachusetts General Hospital, where many famous discoveries have been made. (The Corn Industries Research Foundation supplied additional aid.) They selected patients who had not responded to insulin or metrazol.

The majority were negativistic, showing the aversion response to all social contacts and communications. Some were irritable, aggressive, impulsive, and for the most part, in extreme psychotic states, representing that seemingly unsurmountable barrier between reality and unreality, in which fantasy and confusion seem to produce a mental state with extreme negativism and a struggle even against the factors fundamentally essential to the organism's life, such as the taking of food.

All patients had been diagnosed by five or more psychiatrists as schizophrenic. They were all physically normal.

Miss P. M., aged 38, had been sick for eight years. Her clinical course was unaffected by refrigeration.

Miss B. R., aged 41, had been a schizophrenic since the age of 21. For the last ten years she had done no more than vegetate. She did not respond.

Miss S. E., aged 29, had been mentally ill for more than four years. In 1938 she had received two series of insulin shock treatments, resulting in only temporary improvement. On June 12, 1940, refrigeration was tried. Her temperature was maintained below 98 degrees for a total of 38 hours during the first treatment; for 34 hours it was kept below 95; and for seven hours it was below 80, actually falling for a short time as low as 75. She was drowsy and unco-operative for the first day after being warmed up again. Then for two days she was mentally clear—not only displaying a close approach to normal responsiveness but even becoming co-operative. She evanescently exhibited a surprising insight into her condition and vouchsafed that she must have been confused for some time. All who saw her believed that she was better than she had been for more than two years. But after 48 lucid hours she reverted to her former state.

A second treatment followed on October 12. Twenty-nine hours of hypothermy brought only disappointment to the psychiatrists.

A third treatment was given in November, and refrigeration was prolonged to 54 hours, though the minimum thermometer reading was 87 degrees. After 12 hours of restored warmth, she became mentally alert, oriented, able to carry on a normal conversation, yet somewhat suspicious for three days. Since then she has been more responsive and co-operative than before treatment, though maintaining only partial contact with reality.

Connected to the electric refrigerator is a cold "blanket"

Miss H. I., aged 37, sick since 1923, had received several insulin shock treatments without benefit. Refrigerated for 33 hours, she improved markedly through five days, being pleasant, co-operative, appreciative of things done for her. But she reverted to her former state on the sixth day. Three months later, she was made hypothermic again—for 68 hours. As her temperature was allowed to re-approach normal, she became mentally clear and carried on a lively conversation about many topics in a logical and coherent manner—but only for six hours, until her temperature reached 95, when she became confused again. The next day she became lucid again, and for a day and a half gave every appearance of a normal and completely recovered individual. She wrote a letter to her mother and father. She was sociable, courteous, and an interesting conversationalist. Then she slipped back into her mute psychotic state.

If you will note the ages of these patients and the durations of their sickness, you may conclude that the response, if any, is disappointing in older, chronic cases. Yet a discovery is obvious. The mentally ill do respond. Presumably, as is speculated in regard to failures with insulin and metrazol shock, cases of long standing suffer irreversible brain-cell changes. Younger, newer cases provide confirmatory evidence.

S. R., aged 16, was first hospitalized in April 1940. In July, his body was sent below normal warmth for 27 hours, below 95 degrees for six hours, and to a low of 92. During the succeeding four months he improved. His hallucinations and queer ideas vanished. Quiet, polite, friendly, he was discharged as sufficiently improved to live at home.

Miss M. F., aged 25, had had symptoms for about ten years but was first diagnosed as frankly schizophrenic in April 1939. Neither insulin shocks nor metrazol altered her state. On July 29, 1940, general hypothermia was tried. Her temperature was kept below 98 degrees for 29 hours, and below 95 for 22 hours, at one time reaching a minimum of 83. "The adjustment of this patient outside the hospital," Talbott and Tillotson report, "had been unsatisfactory because of hallucinations and ideas of a bizarre, delusional type, and she had had to be confined intermittently. Following hypothermia she returned to her home, and at the last follow-up report it was apparent that she had made a good social recovery and a satisfactory social adjustment."

The most interesting case studied is that of Miss H. A., a medical student, 26 years old, admitted to a mental hospital in 1937. Her disease did not respond to either insulin or metrazol. She was the sickest of the group, but:

"During the first hypothermia treatment, when her body temperature reached 89 F., she commenced to talk. For all practical purposes, that was the first time that she had conversed in more than two years, being for the most part mute and combative. She

talked clearly, logically, and with insight, and expressed herself normally until her temperature reached 93 F. At this level her conversation became confused and her speech thick. During the four intervening hours she had looked and acted quite normal and could not have been diagnosed as suffering from schizophrenia. When her temperature reached 96 F., she became mute and reverted essentially to her former schizophrenic state."

For three months her conduct was but barely improved. She was less combative, yet refused to talk.

After another two months she was refrigerated again. She repeated her previous performance. When her temperature reached 88 degrees, she became mentally clear and conversed for nearly four hours with her father, a physician. But, as before, when her temperature was raised to 94 she became once more unresponsive and confused. As her temperature approached 96 she was mute.

The following month brought no improvement. A third treatment induced the same queer response. As her temperature reached normal, she reverted again, and remained mute, combative, unco-operative.

At the end of 48 hours, however, she suddenly came out of her schizophrenic world, asked for her personal effects, expressed a desire to dress, requested her eyeglasses so that she could read. Once more she was herself, an intelligent, social personality.

For two weeks she stayed well. Thereafter, she tended to fall into moments of confusion, became overelated and boisterously active at times. Still, her general improvement has been sufficient to permit participation in occupational therapy, and a "fairly adequate social adjustment" has endured.

These and other striking results justify further investigation of hypothermia in insanity. In the words of Talbott and Tillotson:

"A more comprehensive statement and a definite conclusion will have to await further application in a far greater number of patients together with a longer follow-up study. The clinical results seem to be at least as promising as insulin and metrazol in the treatment of schizophrenia. That hypothermia may be beneficial in various phases and types of manic depressive psychoses is a subject which we hope to investigate in a similar study, presently."

A search of the medical literature showed Talbott and Tillotson that their success was not the first. A century and a half ago, in 1798, Dr. James Currie, Liverpool (England) Hospital physician, reported how he benefited a young man frenzied by insanity. Currie ordered the patient to be thrown headlong into icy water. "He came out calm and nearly rational," Currie wrote, "and this interval of reason continued for 24 hours. The same practice was ordered to be repeated as often as the state of insanity returned. This direction has been followed, and two days after the first treatment, he was thrown again into the cold water bath at the height of his fury as before. As he came out, he was thrown in again, and this was repeated five different times, till he could not leave the bath without assistance. He became perfectly calm and rational in the bath and has remained so ever since."

Modern psychiatry had to wait for Fay to astonish medical scientists by showing the safety of human hibernation in a bed of cracked ice—refrigeration which you had better not try out in your home since there are many fine medical points to be considered with the utmost care during hypothermia; respiration, heart beat, possible frostbite. For example, a temperature tumble below 75 degrees may be fatal. In human hibernation, life comes as close to death as it is possible to go—and return safely. In the weird world of cold life, you are suspended in the mysterious dark that lies midway between life and death. A medical expert can send you without risk into that dark icy slumber, but even he must have first rate hospital facilities.

The present writer has had a letter from Dr. Talbott, who replied to a query regarding new research: "Due to my participation in our war effort I have been forced to discontinue the hypothermia treatments, and probably shall not resume them for some time to come." One more charge against Schickelgruber.

Resumed these researches will be—of that we can be sure.

• • •

BETTER TESTS

Why Are So Many Being Rejected for the Draft?

Is our national health declining? Such is the suspicion voiced by some who have read about the results of tests on selective-service registrants and note that, in the present war, a large proportion have been rejected. The true reason is rather the opposite—health is better, but medical science is today able to detect ills which, in the last war, were not found until the men were in service and which cost the taxpayer money because men likely to develop disease were inducted. In *The Journal of the American Medical Association,* Leonard George Rountree, M.D., Colonel in the United States Army Medical Corps and Chief of the Medical Division of the Selective Service Division, also Kenneth George McGill, Chief of the Research and Statistics Division, and Captain Oliver Harold Folk, Chief of the Medical Statistics Section of the Research and Scientific Division of the United States Army, have analyzed the health of selective service registrants and they find that:

"Advances since 1918 in clinical medicine and diagnostic laboratory procedures now present the means of eliminating more men from the service. For example, many registrants are being rejected because of latent syphilis that would not have been recognized in the World War. Chest roentgenograms are being used extensively. Many cases of tuberculosis are being found now that could not previously have been detected."

ELECTROCUTION

Home Treatment by Electric Devices May be Dangerous

In a communication to *The Journal of the American Medical Association,* Dr. Richard Kovacs of New York has described a tragic happening and observed that any kind of self-treatment with electric devices may cause death when applied by the inexperienced.

A resident of Long Island was found lying on the floor of his bedroom, fully clothed except for his coat. A metal electrode was on the back of his neck, slipped under the collar and held in place with a scarf. A wire led from the electrode to the radiator and was wired to the radiator. A rheostat was plugged in a wall socket, the handle of a "violet ray" machine was on the deceased's chest and a circular hollow piece of metal was in his left hand.

To reconstruct the sequence of of events, the deceased undoubtedly attempted to treat a back pain with the violet ray contraption and, in the mistaken belief that "grounding" would increase the strength of the current and thus the efficiency of treatment, after plugging in the handle of the violet ray outfit, rigged the connection between the radiator and the metal plate on the back of his neck.

No better way could have been devised to conduct the alternating current from the return ground through the heart area. Hence, as soon as the current flow was started, it caused local burns at the point of entry and instantaneous death.

OUR *Point* OF VIEW

YOU CAN'T SHRUG IT OFF

As THESE words are written, our Navy and Marines have re-taken from the Japs some islands in the southeast Pacific. By the time this is in print, we may know what it cost to drive the yellow men from those points. By then, too, we may have some conception of the cost in American lives of the presently-promised Anglo-American air offensive over Germany and of the Ranger raid on Dieppe. None of these costs will be nominal. The price we will pay to recover other Axis-infested parts of the world must not be forgotten as easily as were the oft-published traffic injuries and fatalities after each national holiday, before G. R. (Gasoline Rationing). So long as the individual was not concerned in one of those frightful highway tolls, the initial shock was easily shrugged off in favor of baseball scores, golf tournaments, or editorial comment.

There is something altogether too reminiscent of that careless casualness in the present attitude of the average American toward the bloody Armageddon now raging throughout our world. With far too many of us the ghastly awakening shock of Pearl Harbor has all but worn off. Although subsequent engagements with the foe have brought succeeding casualty lists; although our merchant ships, with a horrifying percentage of their crews, have been sunk faster than we can make them; although our armed forces, in about a year from now, will number at least half again as many men as we mobilized in World War I—compared to an army of 188,000 before the war; although our national life has been regimented and rationed as never before; although we have lost the Philippines, part of the Aleutians, and other possessions; although, in fact, we are losing the most important war of our existence, there are still too many of us who don't know what it is all about, who have no real conception of the super-seriousness of things as they are today—and who, in some cases, don't give a damn.

Why? What's wrong?

Doesn't the fact that naval casualties to date have exceeded those of the other war (77 officers, 794 men) by thousands mean anything? Doesn't it register that the manpower loss in killed, wounded, and prisoners in the single campaign of Bataan nearly equalled the total killed in action in the former A.E.F.? Can't we all understand that this is not a stream-side picnic of happier days? Is it beyond our conception to realize what it means to have the grasping tentacles of the Axis Powers increase their control of world production since 1938 over rubber from zero to more than 90 percent; crude petroleum, from .4 to nearly 7 percent; bauxite, from 25 to 65 percent; tin ore, from 9.4 to 73 percent; zinc, chrome, iron, and manganese ores, in comparable percentages? Today, we, the United States of America, are a have-not nation in so many crucial items that one wonders how we ever had the temerity to say: "We don't need the rest of the world. We can live unto and by ourselves."

The implications of these and other statistics not only are vital—they are vicious! We *must* wake up! We *must* understand, or else . . .

Again, why? What's wrong with us?

Outstanding among several contributing factors are two: the ever-more confounding confusion regarding availability of gasoline, fuel oil, rubber, clothing, sugar, other foods, and various daily-life items—for which only the government and its multifarious bureaus, departments, committees, "spokesmen" and their continually conflicting reports, estimates, theories, and what-have-you's can be responsible. Who knows whom to believe and what? And if we can't have dependence on what our leaders say about some problems, why should we get into a dither about their other pronouncements? Let us have clear, keen, truthful statements—facts, honest facts, even if they hurt—from sources known to be responsible. Then that irritable, self-satisfied, smug, what-the-hell attitude will largely disappear. Every John Q. Public will then find that he *is* concerned, that he *must* take greater cognizance of what goes on at Tulagi, at Stalingrad—or his way of life and that of his children will submit to the now too largely disregarded Axis menace that so threateningly overshadows him.

The other primary factor concerns us—each and every one of us, regardless of what sacrifices we may have made, or think we may have made to date. "There is no doubt that the American people mean to win the war," said Elmer Davis, "but there is doubt that all of us realize how hard we are going to have to work to win it. The war is a long way off . . ."—and that is one of our troubles. It was a long way off from France and England in late 1939 and early 1940, when German and French soldiers fraternized across the Maginot Line, when British aircraft dropped leaflets instead of bombs on the Reich. There was international smugness and things weren't too tough. Then it happened.

So it is with us. We haven't heard screaming Stukas or Zeros. Bombs haven't—at this writing—smashed buildings, torn our women and children limb from limb. It's all so far away—and it probably won't get over here anyway. The Germans are too busy with the Russians; after Midway and the Coral Sea the Japs aren't strong enough to attack our mainland. Let George do it!

So? *This* is a total war, and the word "total" has no half-way meaning. In total war you either are, or you aren't; you either live or you die, individually, nationally. We must recognize the gargantuan size of this conflict, its hideous, world-wide machinations. It is a known fact, now, that Axis strategy includes the conquering and subjugation of the United States. It can be done, both physically and economically, by the most ruthless, coldly-calculating, best informed, cruelest gangsters and mobsters the world has ever known. As matters stand this minute, only one thing can stop them and lick them—American ingenuity and courage, coupled with those same, already demonstrated factors on the part of the folk of the United Nations.

To accomplish our share, we Americans need two things: an administration policy that will give us the clear, cutting, unadulterated truth, so far as is compatible with national safety in war-time; and we, the people, must realize we have no surplus of resources, productive capacity, or time—that this is a fight to the finish, and that more of us must get more than "ankle-deep" in this war, or we'll lose it.

—A.D.R., IV

Future Sources of Power

A Systematic Survey and Evaluation of All the Power Sources at Present Known to Science

C. C. FURNAS, Ph.D.
Professor of Chemical Engineering,
Yale University

THE sun's rays shower as much energy on the earth's surface in one minute as the entire human race utilizes in one year. Despite the presence of this bountiful and unusual flow of energy, a large part of the struggles of the human race are concerned with acquiring and controlling sources of power. Evidently our state of development in the utilization of power is still rather crude. Thus, a review of the various practical sources of the present day is in order.

The energy supply which is most critical in America is that of petroleum. At the present time we are using something over a billion barrels per year. The known proved reserve of petroleum in the ground is 12 to 15 billion barrels, depending on who does the estimating. Thus the petroleum actually in sight is only about a 12-year supply. But new discoveries are being made constantly, so most of the people in the petroleum industry say they are not worried about the supply, at least for the present generation. It is a little discouraging to note, however, that the new discoveries are not quite keeping pace with use, so the pinch of partial depletion may come sooner than the optimists anticipate.

There may be discoveries of great new fields but the prospects of that are not very good. There is the possibility of extensive fields lying under the ocean next to coastal plains such as border the Gulf of Mexico. There may also be a great deal of petroleum at far greater depths than are yet explored. We live in hope that there are, but it should be remembered that if recovery is made from the more difficult places, the cost of production is certain to rise and the customer must pay for it.

Technical advances in refining have greatly extended the potential life of the petroleum resources. The widespread utilization of cracking has more than doubled the yield of gasoline and hence has more than doubled the potential supply of motor fuel. Now the polymerization of refinery gases into liquid fuels is beginning to come in and is helping to extend the life line of petroleum. Such technical advances are a great factor in keeping up the liquid fuel supply, but eventually, perhaps distressingly soon, the pinch of depletion will begin to make itself felt. What then?

There are several possibilities that need to be surveyed and evaluated:

Dr. Abbott and experimental sun power plant

I. Getting all the petroleum out of the ground. Even with the best production methods, over half the original petroleum deposit still stays in the ground after the well has gone dry. Mining of the sands appears to be impractical, not to mention being very expensive. If some one will devise an inexpensive means of breaking the adsorptive forces between petroleum layers and the sand grains, he will greatly lengthen the life of our oil resources, not to mention the possibility of making himself rich.

II. Shale oil. There are many billions of tons of oil shale in this country which, when heated, will yield from half a barrel to two or three barrels of petroleum-like oil per ton of shale. The potential supply is enough to supply our motor fuel for from 100 to several hundred years, depending on the grade of shale considered acceptable. But mining or quarrying the shale, retorting it, and disposing of the waste costs effort and money. If the refinery cost of gasoline should double above its present cost per gallon, then shale oil might begin to compete. Thus we have a considerable backlog of motor fuel but we shall get it only by paying higher prices than at present.

III. Hydrogenation of Coal. Germany and, to a certain extent, England are making fairly satisfactory liquid fuels by reacting hydrogen gas with low grade coal at high temperature and pressure in the presence of a catalyst. But the cost of production is about 20 cents a gallon compared to the American cost of five to six cents a gallon from petroleum. That high cost might be lowered somewhat but the prospects are that it will not go down materially. Thus we can drive our cars on motor fuel from coal, but we'll have to pay dearly for it.

IV. Alcohol from agricultural products. This is great fuel for politicians from the corn belt but not so practical for automobiles. First item is cost—15 to 20 cents a gallon under best practice. Next, lack of supply. A small fraction of our fuel might be supplied from waste and surplus farm products, but it would require nearly all the good crop land in the country to supply our motor fuel demand by this means. There wouldn't be anything left to eat.

Summarizing liquid fuels: We can have fuel for automobiles for at least several generations but at a price. The lush days of practically free oil from the ground will begin to end some of these days—probably too soon to please us. This generation may very well feel the pinch of partial depletion. Any economy or conservation steps are very much in order.

Coal: In coal we are the most happily situated country in the world. We have over half of the world's known coal reserve, and less than 6 percent of the world's population. At the present time we have enough coal in sight

(all grades) to last 3000 years. That picture may change if the other 94 percent of the people of the world decide that we must divide up, but that is one of the unpredictables. Hence as regards coal we may say that we are very lucky. But that does not mean we should be negligent of conservation. Within the next 100 years many of the best deposits will be depleted. We shall have to begin to depend on the lower grades. Expenses of recovery will go up, quality will go down. It will be wise to extend the life of our A-1 deposits as long as possible.

Eventually, no matter how much we conserve, this sponging off past ages for fossil energy must cease—the deposits will have gone up in smoke. What then? That's a question which America will face eventually, which many groups of people in the world are facing right now. Other possible sources of energy certainly should be considered.

I. Water Power: The water-power sources of the world are by no means fully developed, but even if they were they would be quite inadequate. About 10 percent of America's energy comes from water power. By full development that could be extended to 20 or 25 percent. It helps but it simply is not enough.

II. Wind: Lots of energy goes to waste in a hurricane or tornado but you can not count on it. The winds are not dependable, even in Kansas. Moreover, the average breeze is at a very low potential as far as energy is concerned. Except for isolated, special cases where a high cost storage capacity can be provided, wind power seems to be out.

III. Tides: In a limited number of places, such as ill-famed Passamaquoddy Bay, the use of tidal power may be practicable if a possible market is close at hand. Like the power from falling water, this may help but it can supply only a small proportion.

IV. Wave Power: Many wave motors have been designed, some of them have been patented. But the item of variability of the source of power seems to relegate this device to the impractical heap.

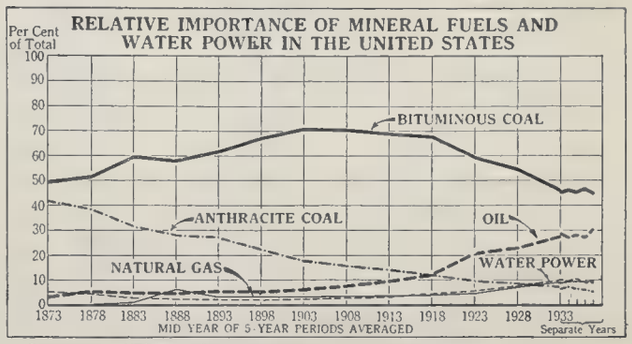
V. Utilization of Current Vegetation: About 50 times as much energy is stored up in plant life on the earth in one year as man utilizes in that year. It might then appear that we could use the present growing trees, grasses, and shrubs for fuel and thus solve the problem. Close investigation makes that idea discouraging. In the United States we would have to use nearly all our annual crop of vegetation (trees, grass, farm crops) to meet the energy demand. Nothing would be left to eat and the land would all be a desert in a few years. We cannot push vegetation very far from its natural cycle. All the data show that we cannot go back to a tree- and bush-burning economy.

VI. Atomic Energy: The business of smashing atoms to release great gusts of energy is a profitable sport—for news reporters. But it is not an item that has much standing in physics laboratories. Radioactive materials, of which there are only minute amounts in the earth, disintegrate and slowly release large amounts of energy. If radium, for example, were as plentiful as copper, atomic boilers using radium as fuel might be practical, but there just is not very much radium available. As far as artificial disintegrations are concerned, the verdict thus far seems to be definitely thumbs down on such operations for giving a net yield of energy. Far more energy has to be put into the operation than can be got out. There is some evidence that one of the isotopes of uranium, if relatively pure, might, upon bombardment with neutrons, disintegrate to give a net yield of a rather large amount of energy. But this isotope of uranium is one of the rarest of rare materials. Other materials tried have not so far shown any hopes for energy production. Thus any Atomic Energy Development Company seems to be facing a stone wall of discouraging facts. One cannot arbitrarily say that we shall never be able to get energy from atomic disintegration but in our present forecasting we shall be on safer ground if we do not count on it.

This brief survey has not answered the question of where we shall get our energy, but it has pretty well covered the possible sources—excepting one—the direct utilization of the energy of the sun's rays.

The average intensity of solar energy in this latitude amounts to about 0.1 of a horsepower per square foot. The energy falling on one square yard of roof would more than operate all the electrical household appliances, including lights, of the average family—if it could be directly utilized. Most factories have sufficient energy falling on the roof to operate all the machinery in the place—if the management had enough ingenuity to utilize it. No one has developed that ingenuity yet.

One of the obvious possibilities for direct utilization of solar energy lies in photo-electric cells. Thus far photo-electric cells have operated with microscopic efficiency and have been very expensive. If some one can make revolutionary improvements in photo-electric cells, and can cut the cost of construction away down, we might have something there. At present the prospects are discouraging but one hesitates to say that such utilization is forever impossible. Even with the items of efficiency and cost brought under control, the matter of storage of energy during periods of darkness would be troublesome. Large storage reservoirs of water might solve this problem—pumping water to high levels in daylight hours, using it in water turbines during darkness. The overall efficiency of such storage can be about 70 percent. In general, it may be said that photoelectric cells are barely possible but not hopeful.



Courtesy, "The Index," New York Trust Co.

Graphs showing trends in power sources

The simple and obvious device of using focused sun's rays to heat up a liquid has been toyed with for a long time. Solar boilers of various degrees of impracticality have been born in many inventors' minds and the subject of many patents. Dr. Abbot, of the Smithsonian Institution, has a small solar power plant with revolving parabolic mirrors for which he claims an electrical energy production efficiency of 15 percent. We shall have to do better than that if the sun's rays, which are not at very high intensity to begin with, are to be a practical source. It is not likely that the efficiency of the solar power plant, if it operates by steam generation, can be greatly improved.

On the other hand, solar energy may very well be on the verge of being practical for heating of buildings where a high potential is not important. The storage capacity must be sufficient for weeks or even months of operation. A basement full of hot water, periodically reheated by the sun's rays, might be possible, but it hardly sounds prac-

tical. A closed cycle, employing a low-boiling liquid, might better serve for such storage. First costs would be high but operating costs might be cut to the vanishing point.

Such an idea may bring a smile but it is now becoming almost respectable; the Massachusetts Institute of Technology has begun experimentation along this line. [See "Harnessing the Sun," Scientific American, June 1942, pages 284-286.—*The Editor*]

The foregoing suggest some interesting ideas but, with the exception of heating buildings, they do not seem to come within gunshot of practicality. I have saved what I consider to be the best idea until the last: namely, men should try to do efficiently what nature has been doing inefficiently for a billion years—utilize photo-chemical reactions. The basis of all life is some simple photo-chemical reaction thought to be

$$H_2O + CO_2 + \text{Radiant Energy} = HCHO\ (\text{Formaldehyde}) + O_2$$

The formaldehyde immediately forms simple sugars which then serve as the basic material for the multitude of complex compounds in plants. What we should like to do would be to take some such simple compound as formaldehyde formed with the help of radiant energy, put it in an electro-chemical cell, expose it to oxygen, and then reverse the above reaction and get back the stored energy as electrical energy—at high efficiency. Formaldehyde can be oxidized in a cell in a basic solution to give formic acid and a small amount of electrical energy. Perhaps all that is needed is a proper catalyst to complete the oxidation to CO_2 and water and get back all the stored energy.

The catalyst which nature uses for performing the photosynthesis of the above equation is chlorophyll. That's the best catalyst known but it is very poor. Plants are very inefficient stores of energy. Even the most luxuriant plants have an energy-storage efficiency of less than two percent. We ought to be able to do a lot better than that.

It is a wide open field—this study of photosynthesis and the study of oxidation cells which will reverse the reaction. That is the reason it is hopeful. The systems which might be used would not have to be limited to organic compounds. It may well be that inorganic compounds offer the most hope. The satisfactory system would need to be one that is as light-sensitive as the chemicals on a photographic film, as easily reversible as a lead storage cell. If such a photo-chemical-electrical system can be developed, the problem of energy capture and storage would be solved. The storage of the energy would be simply that of storing chemical compounds. We are used to doing that with coal.

Some day the photo-chemical approach to energy utilization will either be solved or definitely proved impracticable. In view of our own energy resources it may seem foolish to start working on it now. But it may not be too early to start. If we wait too long we may be caught short as energy supplies dwindle. Moreover, many parts of the world already suffer from insufficient energy. Many international problems might disappear if every group of people could fully utilize the energy falling on its rooftops.

Enough energy falls on about 200 square miles of an arid region like the Mohave desert to supply the United States. When we become ingenious enough to utilize efficiently the energy treasure wherever it may fall we may solve many of our economic problems. It might be a little hard on the railroads that haul coal, but everyone else would benefit.

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FREE ELECTRONS

May Explain Behavior in Iron Alloys

Loose electrons which float around between the atoms of solid iron and its alloys are responsible for many of the properties of these alloys, said Dr. Roman Smoluchowski, speaking recently before the American Physical Society.

He presented a new conception of the role which these "free" electrons play. Applied in practice, it may lead metallurgists to a better understanding of what happens when other elements are added to iron, making the alloys so important to industry, in peace as in war.

Atoms of iron, like others, consist largely of electrons, each carrying a negative electrical charge, encircling a positively charged nucleus. These atoms are arranged in a lattice formation, making up the metallic crystals.

But also in iron, as in all metals which are electrical conductors, there are other electrons floating around in this lattice, not connected to any particular atoms. The drift of these so-called "free" electrons is responsible for the conduction of electricity as well as of heat.

Pure iron at ordinary temperatures has a crystal structure in which the atoms are arranged in the form of interlocking cubes, the corners of each cube forming the centers of adjacent cubes. Thus they form what is called the "alpha phase" arrangement, and this makes for toughness and strength.

However, when iron is heated there is a change at the temperature of 900 degrees, Centigrade. It then goes from the normal alpha phase to the "gamma" phase. Here the atoms are more closely packed than in the alpha phase and the whole metal contracts slightly. If the heating is continued, at 1400 degrees, the metal changes back to the alpha phase, which is retained until it melts, at 1535 degrees.

When other metals are alloyed with iron, they form a solid solution, comparable to liquid solutions—salt in water, for example. Some alloying metals increase the range of temperatures over which the gamma phase occurs, while others decrease it or eliminate it entirely. Knowledge of their effects is very important to the metallurgist in planning an alloy for a particular use. If a part in a machine has to withstand a temperature of perhaps 1000 degrees, Centigrade, it would not do for the alloy of which it is made to change phase while in operation. One then has to add a metal which prevents formation of the gamma phase. On the other hand, a metal which would have this valuable property might introduce other undesirable properties, as for instance, lessened resistance to corrosion. Hence it is necessary to have a selection of alloying agents, from which the proper choice may be made.

All the 92 elements can be arranged by their atomic weights in a checkerboard fashion, to form the well-known "periodic table." Iron comes close to the middle. It has been found by previous experimenters, said Dr. Smoluchowski, that all the elements to the right of iron (and which can dissolve in it) increase the range of temperature at which the gamma phase occurs. All to the left, with a few exceptions which can be explained, decrease the gamma range, or eliminate it entirely.

According to Dr. Smoluchowski, this remarkable regularity is explained by changes in the energy of the free electrons in the crystal lattice of an iron alloy with the addition of other atoms. "The elements to the right of iron, such as nickel, cobalt, and platinum, have more free electrons per atom than iron," he stated. "Thus they contribute electrons to the iron lattice. In contrast, those on the left, including vanadium, chromium, tungsten and molybdenum, take them away."

Fluorescent Lighting Stretches Out

Cold-Cathode Tubes, Operated at High Potentials, Have Interesting Applications for Many Uses

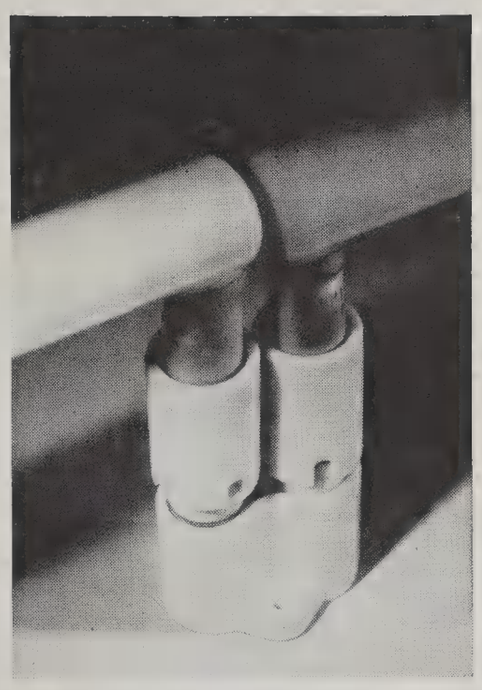
AUSTIN C. LESCARBOURA

FLUORESCENT lighting is being stretched out as the next step in the spectacular development of tube lighting. Continuous cold-cathode fluorescent tubing, as distinguished from the usual hot-cathode fluorescent lamps with their fixtures, and in lengths up to 20 or more feet and in parallel lines, curves, circles, or other shapes to follow architectural contours or specific illumination needs, has been appearing of late in plants, drafting rooms, offices, stores, and other establishments. The fact that this improved fluorescent illumination utilizes all available light, since no diffusion screens are required; that it stretches out the total light over the widest area as contrasted with lamps spotted here and there in fixtures; that it does away with elaborate fixtures and accessories, and even reflectors where white ceilings are available; and that it requires an absolute minimum of hard-to-get materials, has earned for it the significant nickname of "the victory light."

Cold-cathode fluorescent lighting, however, is just another old idea in modern streamlined dress. Many of us recall the Geissler tubes of our physics classes or home experiments. Those glass tubes, blown or bent into decorative shapes and sometimes surrounded by fluorescent liquids held in outer glass jackets, were connected across a spark coil or static machine so that the electrical discharge caused them to glow in various attractive colors. Out of that old idea came the colorful and vivid neon and other gaseous-tube advertising signs that converted night into day along our Main Streets until blackout ordinances compelled reversion to the blackness of the night, and incidentally left thousands of neon sign shops without a reason for being—temporarily, at least.

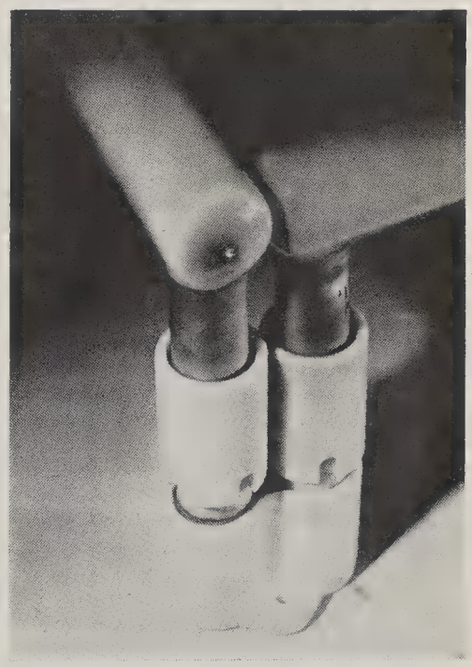
It so happens, however, that the neon sign technique can, with due thought and care, be converted into an advanced form of fluorescent lighting. First, tubing that emits a white light takes the place of the colorful tubing used for advertising displays and decorative purposes. Second, the manufacturer or contractor handling finished tubing and installations now thinks in terms of total lumens, and foot candles, and lumens per watt. Third, the industrialist, seeking the most satisfactory illumination for his workers averaging 60, 70, and even 80 hours weekly, is attracted to the easy-on-the-eyes merits of cold-cathode fluorescent lighting. Fourth, in order that there may be standardization of products and installation practices to safeguard the buyer against being made party to an experiment, the Fluorescent Lighting Association, comprising leading manufacturers of cold-cathode fluorescent products, joined by contractors keenly interested in this latest illumination means, is formulating and issuing definite standards covering approved products and installation practices.

COLD-CATHODE fluorescent lighting is probably the simplest form of illumination so far developed. It consists of nothing more than inside-coated glass tubing properly evacuated and filled with argon gas and mercury vapor, fitted with metal electrodes, and sealed. Such tubing can be straight or bent to any shape. Several lengths, each up to eight feet long or more, can be connected together in series, on one transformer. Parallel rows of tubing can be used where a higher level of illumination is required. The transformer steps up the 110-volt A.C. to the necessary secondary voltage required for the satisfactory operation of the tubing. Usual operating voltages run anywhere from 3000 to 15,000, depending on the tube footage, number of tubes in series, tube diameter, and other factors, all reduced to definite mathematical formulas and tables. The current flowing through cold-cathode fluorescent tubing is generally of the order of 60 to 150 milliamperes, depending on several interlocking factors. Tube diameter generally runs from 12 to 25 millimeters.



Tubes come close together in mountings, leaving minimum dark space between

What actually happens in the cold-cathode fluorescent tubing is that the coating inside the glass tubing is activated or caused to glow under the action of the ultra-violet light generated by the passage of current through the gas in the tube. The glowing phosphor or fluorescent coating causes the entire length of the tube to emit light. Thus the light is spread out over many lineal feet, instead of being concentrated—as in the case of the usual incandescent lamp—into a few square inches, or again into the 9-inch to 5-ft. length of the hot-cathode fluorescent lamps. The cold-cathode fluorescent tubing stretches out to many feet and, with this stretching process, the surface brilliance or glare of the tubing per unit area is correspondingly lessened. Referring again to the incandescent lamp, we have the light concentrated in a few square inches, with even the translucent bulb still too



Mountings are easily adapted to angular arrangement of the cold-cathode tubes

New lighting method is simplest form—no reflectors or diffusers

bright to permit such a light source to be used unshielded if we have due respect for our eyesight. The hot-cathode fluorescent lamp was a big step ahead, for the surface brilliance is considerably reduced as the light source is stretched out to four or five feet. Now comes the cold-cathode fluorescent tubing, stretching out to 20 feet for the same light output, and the surface brilliance is so lessened that one can look directly at such light source for hours without visual discomfort. Thus, in the case of cold-cathode fluorescent lighting, no diffusion means or translucent screen is required, which means that instead of sacrificing anywhere from 25 to 40 percent of the light output for diffusion purposes, the full light output is put to useful work.

THE stretching of the light source also serves to distribute the light to best advantage. As contrasted to lamps in fixtures spotted here and there, the cold-cathode fluorescent tubing spreads over the area to be illuminated so that there are no light and dark areas, but rather a uniformly well illuminated area. Since this light source operates at a relatively low temperature, the tubing can be mounted close to a white ceiling, which ceiling then serves as the reflector. Simple hangers suspend the tubing. Where a white ceiling is not available, the tubing may be placed in suitably painted plywood reflectors. No metal is necessary for the reflector, and no other fixtures are needed except the simple connecting sockets.

Although cold-cathode fluorescent lighting still is in its infancy so far as actual application is concerned, rapid progress is being made because of the Association's activities. Already suitable porcelain mountings are available, permitting the tubing to be held in series or in parallel, and at various angles in respect to successive lengths. Suitable transformers are available, and decorative housings are now coming through to dress up the installations in offices and stores.

Fluorescent tubing for utilitarian illumination comes in three shades of white termed "Soft White," which has a pinkish cast for a pleasing atmosphere consistent with good lighting; "3500 Degree White," in strict accordance with the color designation of that term; and "Daylight White" which is more on the blue side and suitable for revealing true color values.

The white range of fluorescent tubing is more efficient than that of incandescent lamps because the light output for the former is from two to four times greater than for the same wattage input, while the heat radiation is from 25 to 50 percent less. The latter consideration is important when dealing with showcase lighting, or in confined working quarters, or again where air conditioning is being used.

THE simplicity of cold-cathode fluorescent lighting is another basic reason for the growing popularity of this form of illumination. There are no accessories or starting gadgets of any sort required. Just the tubing and the transformer complete the equipment proper. When the power switch is closed, the tubing lights up instantly, at full illumination. There is no delay, no sputtering, no flickering. With the absence of starters or accessories, there is virtually nothing to get out of order. The maintenance is reduced to nothing more than wiping off the tubing with a damp cloth from time to time, to assure full illumination.

As for life, typical installations show a tube life of 10,000 hours to as high as 30,000 hours in actual service, as

Typical shop installation. Transformers are above reflectors

contrasted to the 2000-2500 hour rating of hot-cathode fluorescent lamps. Furthermore, there is little falling off in light output with cold-cathode fluorescent tubing, as compared with a considerable loss of light for both the incandescent and the hot-cathode fluorescent lamps as they age. Cold-cathode fluorescent lamps have no filaments to burn out or break from jars or vibration. Cold-cathode life is not reduced with frequent starting, whereas life is reduced with each starting of standard fluorescent lamps.

Because cold-cathode fluorescent lighting requires so little hard-to-get materials, particularly when freedom from replacement is considered, this form of lighting is receiving favorable priority consideration.

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GLASS

Now Made Without Use of Sand

In windows, glass is used to admit light; in optical equipment it must refract, disperse, or condense light, and better control of these functions has long been the aim of research.

Ordinary glass has as its principal constituent silica in the form of sand, whereas a new "rare element" glass, developed by Eastman, contains no silica as sand but, instead, various compounds of tantalum, tungsten, and lanthanum with boric oxide. Such a glass, suggested eight years ago by Dr. G. W. Morey of the United States Geophysical Laboratory and developed with his collaboration, has a refractive index high in relation to its dispersion, imparting to it unusual "light bending" ability. This makes possible a lens of considerably less curvature for a given focal length, which means that the path of rays through the lens margin will approximate more closely that of rays passing through the center. Practical application in aerial cameras with compound lenses gives better "definition" over a wider area, but with no loss of lens speed.

At present, "sandless" glass is being manufactured only on a small scale. Before it may be used generally for photographic lenses, different grinding formulas must be worked out, as its higher refractive power prohibits the application of standard silicate glass formulas. Even then, sweeping replacement of optical glasses now being used is not anticipated. Since the new glass is much more expensive, due to costlier materials, whose high density also increases the cost per volume, it will be substituted only where its superior ability to give improved definition over a wider area (as in high-aperture lenses) justifies the extra cost.—*Industrial Bulletin of Arthur D. Little, Inc.*

LIGHTNING CHARTED

To Provide Defense for Power Lines

To prescribe adequate defenses for power lines, Westinghouse engineers now plot lightning charts, called probability curves, to anticipate the approximate number of lightning strokes that will bombard power lines during a given length of time. It has been learned, for example, that every 50 miles of power line will be hit by lightning an average of 50 times every year. Each stroke will have a potential voltage of between 20 and 30 million volts as it streaks earthward from a cloud. Forewarned, power-line designers can erect defenses that prevent lightning strokes from short circuiting transmission systems and disrupting electric service to vital war industries.

Filmed measurements of lightning give data for "probability curves"

The lightning charts have been made after engineers spent four years measuring the power and speed of lightning, and gathering data on the number of times that thunderbolts strike in a given area. They found that an average of 10 lightning strokes bombard every square mile of the United States every year; that the average stroke consists of about 20,000 amperes of electricity (enough to momentarily light a city of 15,000 population); and that the speed of lightning varies between 30 million and 200 million miles per hour.

Such lightning data have produced a great improvement in the defense of power lines against thunderbolts during the past 20 years. Two decades ago nearly every one of the 50 lightning strokes that hit a 50-mile power line each year knocked out service at least temporarily. Today, a properly designed 50-mile power line is unlikely to be put out of service by lightning more than once in five or 10 years.

SWEDISH STEEL

Is Equalled by That Made in Texas

Steel smelted with charcoal in the Swedish way, and as good as Sweden's best, is an American product fostered by wartime changes in the world's industrial setup, according to Dr. Donald F. Othmer, of the Polytechnic Institute of Brooklyn.

Swedish steelmakers have always favored the use of charcoal in smelting because the absence of sulfur and other impurities from charcoal resulted in a very pure, high-grade metal. The Nazi war-lords have taken advantage of their position to monopolize all of Sweden's export production, and they may yet overrun Sweden itself. So we are getting no more Swedish steel.

At the same time, war-stimulated demands for two of the principal chemical products of wood—acetic acid and methanol (wood alcohol)—have caused a great increase in their production by the American wood distillation industry. By-product of wood distillation is a very high grade of charcoal, excellently suited for quality steel production.

In northeastern Texas there is a great deposit of iron ore that has not been worked hitherto because it is too remote from supplies of coking coal. But all over the region there are forests of post oak, of little value for lumber but very good for wood distillation, and, of course, yielding high-grade charcoal.

By establishing one or more wood distilling plants in that region, it will become possible to turn out new supplies of the war-needed chemicals, and at the same time to convert part of the now neglected iron ore into the finest steel.—*Science Service.*

BRIDGE

For Railroad Crossings In Industrial Plants

Designed for use in industrial plants where loading docks and buildings are separated by roadways or railroad

Bridge in lowered position for crossing railroad tracks

tracks a new power operated cross-over bridge has been made available by the Montgomery Elevator Company.

Operation of the bridge is similar to that of an elevator. When not needed the bridge is housed overhead, out of the way. When loads must be trucked across the open space, a control button is pushed and the bridge descends into grooves provided for it. When trucking is finished, the button is pushed and the bridge automatically returns to its housing overhead. Time required for raising or lowering is less than one minute. This eliminates cumbersome drawbridges and special transfer cars. Danger to employees is also reduced because they do not have to venture onto the tracks or roadway.

FOREST RESOURCES

Heavy Demands Will Come After the War

THE inroads that have been made by war into the timber capital of most European countries will inevitably result in a reduced forest productivity for a long period after the war, C. L. Forsling, assistant chief of the Forest Service, United States Department of Agriculture, said in an address prepared for the Second Inter-American Conference of Agriculture, held in Mexico City.

Following the war, he said, there is likely to be a heavy demand for lumber and other forest products for reconstruction purposes and to meet the normal needs that have been postponed during the war.

"There is reason to believe also that the demand for wood after the war will be large, not only in Europe but all over the world," Mr. Forsling said. "Although some of the supply to meet this increased need can come from other parts of the world, the Western Hemisphere, particularly the countries south of the Rio Grande, will have to supply the major portion. It seems reasonable to expect, therefore, that the countries of South and Central America and Mexico may have the opportunity to develop an export trade in timber. Domestic requirements, which naturally should come first, may be expected to increase.

The development of export trade and increased domestic use will require more knowledge than is now available about the potential uses of the large number of tropical American forest species and the improvement of facilities for marketing. A sound policy of conservation and management of forest lands is basic to sustain foreign markets and to insure adequate supplies for domestic needs in the future. Collaboration in a number of ways should prove helpful in developing the forest resources of the Americas."

MIDWAY PLANTS

Two Rare Varieties Found on Desolate Islands

AT least two plants known nowhere else on earth are found on the remote, rather desolate Midway Islands, outpost of the Hawaiian archipelago, according to botanists of the Smithsonian Institution.

One of these is a variety of mint that once also formed part of the former luxuriant plant cover of Laysan—a small, uninhabited island about one third of the way between Midway and the Hawaiian Islands. About 1903 some rabbits accidentally were introduced on Laysan. In 10 years they had multiplied into thousands. They exterminated all the plants and reduced the island of less than two square miles to a sandy desert.

On Midway grows also a species of nightshade—of the nightshade-potato-tomato family. It is known elsewhere only on the small neighboring Ocean Island. The vegetation on both the Midway Islands—Sand and Eastern—is very poor. Only 20 kinds of native plants have been found there, the Smithsonian botanists say. The islands are among the most recent bits of the earth to emerge from the sea and afford an interesting example of the tendency of life to fill every possible spot and turn it into a suitable habitat.

Originally seeds of plants could have been brought there only in two ways—by ocean currents or by birds. The likelihood of wind-borne seeds traveling so far is remote. Yet plants have been able to establish a foothold there without human agency. They die and make soil, which provides a habitat for still more plants. Most of the plants are of kinds which spread through the Pacific islands.

Since the establishment of the cable station on Sand Island, several weeds and cultivated plants have been introduced—notably the oleander. The so-called San Francisco grass has also been brought in from the North American continent for the purpose of binding the sand, and various common weeds have come with soil brought in for gardens.

• • •

PAINT—The weather-resistance of a paint is approximately proportional to the angle that the grain of the wood makes with the surface: A wood surface with a vertical grain holds paint much better than wood with a slash-grained surface.

• • •

HOGS OR BEER?

Which is the More Economical Source of Food?

THE energy derived from eating meat is two removes from the original energy source—the sun. That is, the first remove is the vegetable which stores up solar energy, and the second is the animal which in turn stores up some, but only some, of this energy. This is why meat is a more expensive source of energy than vegetables and, incidentally, is why the crowded Chinese cannot afford to eat much meat. Now the British are arguing about the food value of beer. The following, from the *Journal of the American Medical Association,* states the crux of the argument about meat versus beer:

British opponents of the brewing industry, quick to take advantage of war conditions, have called attention to the fact that an appreciable percentage of all available English grain is now be-

How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

▪ ▪ ▪

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ing used for the production of beer. They allege that this grain would be of greater social value if used for the raising of poultry or pigs. "Pigs versus beer" has thus become a current political slogan.

The brewers of England have countered by quoting experimental evidence previously published by nutritional experts of London University. Waller, for example, found that the food value of beer is more than half that of the grain and other material used in its production, while pig meat has less than one fifth the food value of the same materials if used in raising swine.

Moreover, 25 percent of the food value of the grain used in brewing is returned to the farmer in the form of brewers' grains, malt culms, or yeast, foods especially high in vitamin content and nutritive value if used in the animal industry.

The use of beer has also been under investigation by the food controller, who finds "no evidence that beer is doing anything to increase crime or bad health, or to reduce the output of munitions."

From such testimony it is officially concluded by the British cabinet that "it is in the public interest that the production of beer should continue at the present amount" (4 percent of all available grain).

UTILITY LANTERN

Combines Powerful Beam With Extension Light

A GENERAL utility electric lantern which has recently been developed features adjustable focus of the main light as well as an auxiliary light bulb on an extension cord that may be used to illuminate objects not reached by the larger beam. The plastic housing of this lantern is made of Tenite, is light in weight, and yet is so strong as to be virtually unbreakable.

Two-in-one lantern

Railway car inspectors, industrial plants, and servicemen are said to be rapidly adopting this lantern for general use.

BLACKOUT STRIPS

Prevent Light From Showing Around Shade Edges

AN ATTRACTIVE edging around window frames, which also acts as a track for the blackout window shade and, at the same time, prevents any light from escaping, is now available in the form of Tenite strips. These strips, which are produced in both black and white and which retain their high natural luster without the aid of polishing

Light-trap window-frame edging

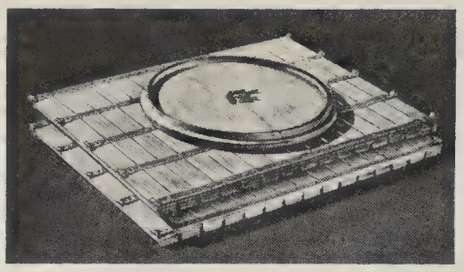
agents, offer a satisfactory solution to the problem of how to avoid cracks of light showing around the edges of blackout shades.

COLLAPSIBLE BARREL

For Bulk Materials, Saves Shipping Space

FOR the shipment of bulk material for which a container is required that can be later emptied and used again, a new collapsible unit offers features of strength and economy. As shown in two of our illustrations, these containers are made in the form of barrels than can be taken apart and shipped flat.

This collapsible container, placed on the market by Planters Manufacturing Company, consists of two plywood heads and two or more assemblies of plywood staves with provision at the ends to retain the heads. Secured to the staves are steel straps which terminate in eyes to take locking pins when the stave assemblies are wrapped around the heads. According to the purpose to which the container is to be



Right: One of the new barrels made with plywood staves locked in place with steel straps. *Above:* One of the containers in collapsed form for re-shipment

put, the design may be such that adjacent edges of staves make tight or loose connection with each other, as may be desired. Individual staves can be removed and replaced if broken.

OIL FROM COAL

New Method Being Checked in the United States

NEW research in the production of liquid motor fuels and lubricants from coal by a process not hitherto investigated in the United States, has been authorized in a recent appropriation by Congress to the Bureau of Mines. The Fischer-Tropsch method, developed and now industrially operating in Germany, has a number of advantages over the modified Bergius hydrogenation method which has been investigated by the Bureau for a number of years. Both methods start with coal, but the Fischer-Tropsch process gives a number of the separated fuel and lubricant products directly, while the output of the Bergius process is a single liquefied coal which is further treated much like crude oil in a regular refining process.

A further advantage of the new method is that much smaller plants are economically possible—about 30,000 tons a day against 150,000 tons a day for the Bergius process. This enables a wider and safer distribution of plants. Also, the Fischer-Tropsch process requires less precision machinery, and it can be used successfully with almost any type of coal, while certain coals with high ash content or extreme sensitivity to temperature variations present serious operating difficulties with the hydrogenation process.

Both processes produce about one ton (between 250 and 300 gallons) of

liquid products from four to five tons of coal.

The experimentation in this country follows reports of the development of commercial processes for manufacturing synthetic fuels from coal in foreign countries, particularly in Germany. The Bergius process was introduced first, probably in a plant at Leuna in 1927, and the 13 known plants of this type at the end of 1940 are believed to have produced about 25,000,000 barrels of synthetic petroleum products a year. Fischer-Tropsch plants, the first of which was reported in 1936, accounted for about 11,000,000 barrels a year in 1940.

Experimentation by the Bureau of Mines assumes added importance because of the war, but basically is directed to obtaining all facts possible so that in the distant day when America may run out of petroleum, a rapid change-over to coal can be made.

• • •

TRANSPORTATION—For every passenger automobile available to carry war workers to their jobs in 1917, there are today six vehicles available.

• • •

"ELECTRIC ARMY"

Represented by Generators at Grand Coulee

THE equivalent of a new army of more than six and a half million husky workmen, laboring 40 hours per week, 50 weeks per year, went into action to speed production of war materials when the Bureau of Reclamation placed in service the third main generator at the Grand Coulee Dam power plant.

The big unit is capable of generating 108,000 kilowatts of electrical energy, 30 per cent more than any other hydro-electric generator except its two mates —an enormous output when it is considered that one kilowatt is equivalent to the physical output of 14 men laboring steadily.

The 946,000,000 kilowatt hours a year which the machine is capable of producing at full capacity will do work equivalent to that of 6,622,560 men laboring 40 hours per week, 50 weeks per year. On an efficient treadmill, such a gang would be able to lift 27,000 tons, almost the weight of a battleship, one mile straight up in an hour.

Figuratively speaking, one work crew of this size—Grand Coulee Dam's first generator—has been laboring on Uncle Sam's behalf since early in October, and a second has been in harness since late in January. Almost the entire output of the three units will be used to make aluminum when new production facilities, now under construction, are provided.

The throwing of the switch on the new machine marked the third time in about six months that the output of the big plant has been enlarged. In that short space of time, its capacity has been brought from a mere 20,000 kilowatts to 344,000, making Grand Coulee Dam, with only one-sixth of its generators in place, one of the largest hydro-electric power plants in the world.

The west powerhouse is scheduled to reach full development in 1944. Contracts have been awarded for six additional units, the first three to be installed in 1943. A powerhouse of similar capacity is being erected on the opposite bank of the Columbia, in the anticipation that more power will be required in the near future.

NOT SCIENTIFIC

Aversion to Non-Caucasian Blood is Emotional, not Factual

RECENTLY there has been agitation about alleged discrimination against Negroes, with regard to the use of

EVENING COURIER
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THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

Dr. Braddock's Microscope Was Commissioned Today

DR. BRADDOCK wants a new microscope—a Bausch & Lomb Microscope . . . and he's going to get it. It won't be today, though, for today America commissioned a new cruiser.

On this ship there are many optical instruments with a myriad of optical parts, made by the same hands that, in other times, might be grinding the lenses for Dr. Braddock's microscope. There are range finders fore and aft, and a score of smaller ones in strategic places about the ship. The glasses with which the officers scan the horizon are Bausch & Lomb products. Yes, and there's a B&L Microscope, a duplicate of the one Dr. Braddock wants, in the laboratory of the ship's hospital.

Dr. Braddock still wants his microscope, but because he knows these things he is willing to wait. Thousands of "Dr. Braddocks" are making earlier victory possible.

Throughout the Bausch & Lomb plant, optical engineers and optical craftsmen are working long and tirelessly to further America's war effort. The lessons they are learning in the white heat of the drive for Victory will be available later to further the peacetime interests of science and industry.

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Impressively masculine is the appearance of Longines Watches for men. The enlarged photo shows Longines 'Curvimatic' with diamond-set dial and 14K. gold case at $175

Longines

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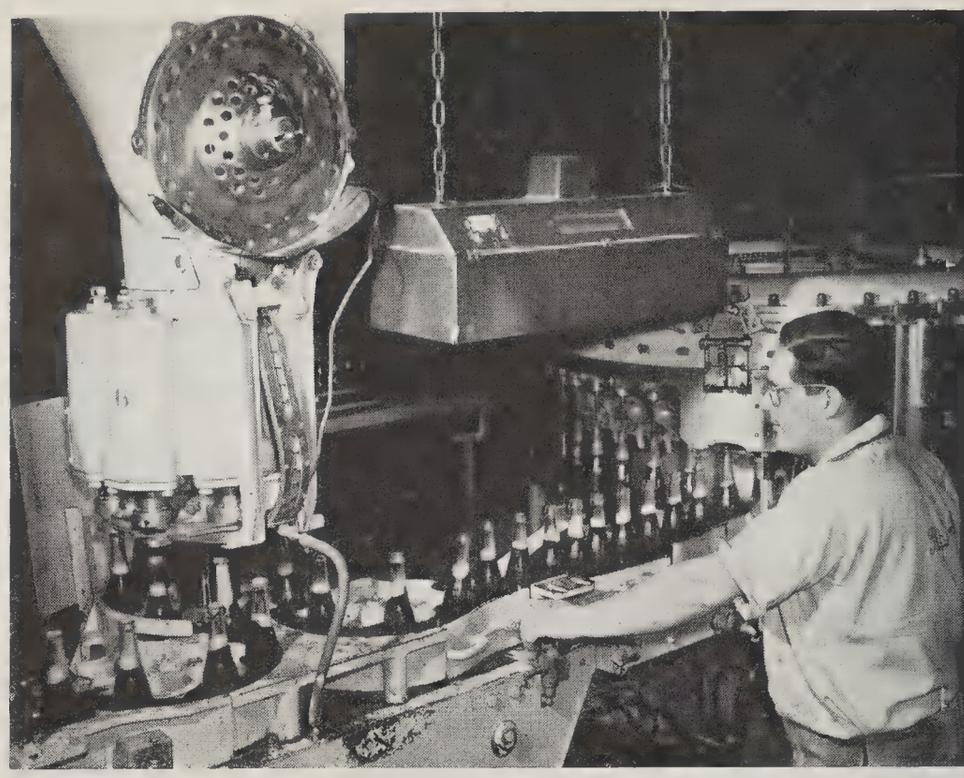
Longines provides watches in a wide variety of style but in a single variety of quality. Every Longines Watch is made to one standard that is world recognized for greater accuracy and long life, and time-tested by 76 years of use. The excellence and elegance of Longines Watches have won them 10 world's fair grand prizes, 28 gold medals and more honors for accuracy than any other timepiece.

Longines-Wittnauer jewelers show the new Longines Watches; also Wittnauer Watches, a companion line of moderate price—product of Longines-Wittnauer Watch Company.

Prices Include Federal Tax



Germ-killing rays emanate from over-head reflector

their blood for blood-banks for war purposes, and the question has been referred to the American Medical Association. The Association has stated, through its *Journal,* that there is no factual basis for such discrimination against the use of Negro blood or plasma for injection into white people.

Since syphilitic blood is eliminated from use for this purpose by thorough serologic testing, the rate of syphilis in Negroes is of no concern in this connection.

The transfusion of Negro blood into white persons and that of white persons into Negroes has been repeatedly performed in civil practice without any evidence of harm or aversion on the part of the recipients.

The present agitation arises from the inopportune publication of orders prohibiting the inclusion of Negro plasma in the military plasma bank.

The aversion perhaps represents the persistence of the ancient folklore that one's personality is closely associated with one's blood. Frequently used clichés, such as "noble blood," are remnants remaining in the language from a day when such superstitions were more prevalent than now.

GERM KILLING

Rays Used To Sterilize Bottles, Contents

SAFEGUARDING every manufacturing step of a soft drink, from the sterlization of the syrup to washing, filling, and capping of bottles, invisible ultra-violet radiations are being used to kill or inactivate more than 98 percent of all bacteria. One of our illustrations shows a hooded ultra-violet unit suspended over bottles about to be capped. At the Long Island City, New York, Pepsi-Cola plant 50 more of these Westinghouse Sterilamps are ranged around the top of a 1,500,000 gallon syrup tank.

• • •

PRESERVING—In spite of a long-clinging fallacy, the charring of wood to protect it from decay has no great preservative value when used alone. A modern treatment combines the charring of wooden poles to remove sap rot and spraying the charred areas with hot creosote.

• • •

FIBER PIPE

Supported by Concrete, Used in Illinois Oil Well

THE world's first oil well to be cased with fiber pipe and concrete as a substitute for steel is in successful operation in southern Illinois, and experts in the industry believe it is the beginning of increased oil production in all parts of the United States, especially in the shallow-well fields.

The experiment with fiber pipe cemented in the well as a substitute for steel in the well was conducted under the supervision of the Illinois State Geological Survey, where the idea of using fiber pipe originated. Based on official figures of well drillings, it is estimated that the substitution of fiber conduit for steel casing will save some 75,000 tons of steel during the next 12 months if drillings continue at the present 1942 rate. Should drillings

reach the 1941 rate, a saving of some 150,000 tons of steel would result, according to this estimate.

According to the Fiber Conduit Company, the use of fiber pipe, supported by concrete, as oil-well casing is "a process which should prove to be of great value to the government, both as a means of saving much-needed steel and of increasing oil production."

TOO SOON

Anti-Aircraft Wires

Invented During World War I

BRITAIN'S newest anti-aircraft weapon, a rocket that trails long tentacles of entangling wires, is no new thing under the sun. Its essential idea was proposed during World War I by Prof. R. W. Wood, noted Johns Hopkins University physicist, who was then overseas in war service. His idea was to have the wires spun out of an anti-aircraft shell. Ordnance men were interested in what they termed the "spaghetti shell," but the war ended before it could be developed to the field-test stage.

Since 1918 the general idea has persisted, and a number of inventors have had a go at it. Shells, rockets, balloons, and airplanes have been among the means proposed for getting the menacing steel tentacles into the air. It has also been proposed to string small bombs at intervals on the wires, to act like miniature mines when the aircraft struck them or pulled them into contact by winding up the wire on its propeller.

VEGETABLE FUEL

Being Used by Power Plants in Argentina

SUCCESSFUL conversion of steam-generating equipment in Argentine power plants now permits the burning of surplus vegetable fuels for power, according to the magazine *Power*. Use of shelled and cob corn, barley, bran, sorghum, seedcake, and sunflower seed husks, almost completely takes the place of imported coal and oil supplies now cut off by the war, the magazine states.

The converted plants are owned and operated by Argentine utility companies affiliated with American and Foreign Power Co. The Calchines plant in Santa Fe has operated entirely on substitute fuels since the early part of this year. Shelled corn is burned on traveling-grate stokers, while bran is fed to forced-draft burners at the rear of the stokers.

A single large boiler at the summer seaside resort of Mar del Plata fires pulverized barley or bran. Corn on the cob, as well as sunflower-seed husks and shelled corn are burned at the Tablada station in Cordoba. Other plants at Tucuman, Mendoza, and Chivilcoy have been converted in a similar manner to utilize substitute fuels. Coal consumption has been completely eliminated in these stations and the quantity of fuel oil for boiler furnaces and Diesels has been materially reduced.

FERTILIZER

Magnesium Content Not Endangered

MAGNESIUM, one of the critical war metals, is also an essential fertilizer element on some soils, but there is no prospect of a shortage of magnesium for fertilizers, say Colin W. Whittaker and William M. Ross, of the United States Department of Agriculture, who have studied the supply situation.

Most soils have magnesium enough to supply the small quantity which plants require. Some magnesium, however, is a prime essential, since chlorophyll, the green coloring of the plant, includes this element. Lack of magnesium causes severe disorders in plants that can be remedied quickly and easily by supplying small quantities of soluble magnesium in fertilizers.

Before the war, the main source of the quickly soluble salt was calcined kieserite, imported mainly from Germany. With this supply cut off, fertilizer manufacturers turned to various forms of magnesium oxide, one of which is obtained by heating dolomite (magnesium limestone), of which the United States has abundant supplies. The heating changes the magnesium in

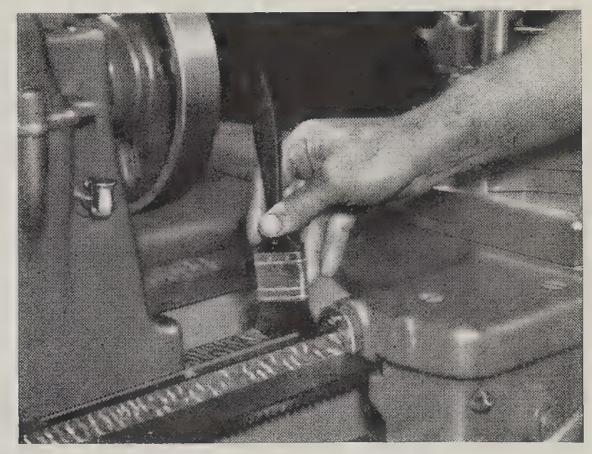
HOW TO GET THE MOST OUT OF YOUR LATHES

No. 1 in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient war production.

Keep Your Lathes Clean

Yes, it's as simple as that. Keep your lathes clean and you increase production, reduce scrap, and lengthen the life of your equipment.

This will not only benefit you, but it will also be a definite contribution to our total war effort.



A small paint brush is convenient for brushing away dirt and chips

Dirt Is Abrasive

The scale, grit and fine chips produced by the cutting tool mix with the oil on the bed ways, dovetails and other bearing surfaces, forming a dirty sludge. Because this dirt is abrasive, it increases friction and causes wear wherever it is allowed to collect.

A small paint brush is convenient for brushing away loose dirt and chips. Compressed air is not so good because it may blow dirt and chips into oil holes and bearings. A clean cloth can be used, after brushing, to remove the last traces of dust and grit. A little oil on the cloth will prevent rust from forming on the finished surfaces.

The felt wipers on the ends of the saddle wings should be removed and cleaned in kerosene occasionally. An experienced machine tool service man should periodically inspect the lathe and remove any grit or chips that may have worked under the saddle or tailstock. The bed ways can be badly scored by a small steel chip imbedded in the saddle or tailstock base.

Don't Let Chips Collect

Adequate chip disposal should be provided to prevent chips from piling up underneath or around the lathe.

Now, when most machine tools are operating 24 hours a day, a small amount of carelessness may cause excessive wear — even a breakdown. Certainly an ounce of prevention is now worth far more than a pound of cure.

Write for Bulletin H1

Bulletin H1 giving more detailed information on the cleaning and care of the lathe will be supplied on request. Reprints of all advertisements in this series can also be furnished.

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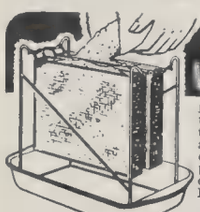

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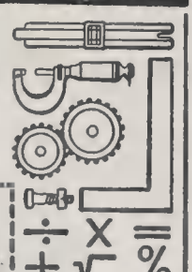

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the dolomite to a more soluble form. In areas where the problem is merely the prevention of a magnesium shortage, and not the need for a quick-acting remedy, the indications are that use of dolomite in mixed fertilizers or in liming fields will supply magnesium that will gradually become available.

Most of the supply of magnesium metal required in the war effort comes from other sources and war use does not affect the supply of agricultural magnesium.

DENTAL CHAIR

Is Fully Adjustable By Automatic Means

A DENTAL chair in which elevation and inclination of the patient are accomplished without moving the patient's mouth from the pre-determined and pre-focused illumination area, and without the necessity for the dentist to remove his hands from critical work at a crucial time to manually tilt chair and patient, has been developed by Dr. Richard W. Page, of Chappaqua, New York. Furthermore, by localization of the mouth area at a pre-determined point and by maintaining that position, the dentist is able to work entirely from a sitting position, thus avoiding the physical fatigue and foot discomfort which aggravate so many dentists. Likewise, cuspidor and rinsing cup at all times are more conveniently located for the patient and are reached by no more than a slight turn at the waist and a brief forward-leaning motion. This is in contrast to the former method of tilting the patient far back in the chair to obtain better operating conditions, a procedure which required the patient to pull himself erect in order to utilize the cup and cuspidor.

"If the operator is to assume the most convenient and restful positions while working," explains Dr. Page, "it becomes necessary in many operations to change either inclination or elevation of the chair, or both, one or more times. Most of these changes result in bringing the mouth out of the effective illumination area of even the best lights. This, in turn, places both patient and operator in awkward, uncomfortable positions in an effort to secure better lighting, or it requires the operator to use his hands to adjust chair and light, often at an inconvenient time and requiring re-sterilization of the hands."

In the dental chair shown in two of our photographs, changing the inclination or elevation is accomplished by foot controls. The patient can therefore be positioned in the most convenient manner, even though both of the operator's hands are occupied in the mouth; no matter how far above or below the patient it is desirable for the operator to be, the spotlight is always focused on the mouth and can, therefore, be mounted entirely out of the way of other essential accessories. The drill arm can be short and does not require constant adjustment to reach the patient in various positions.

The chair is recessed in the front section of the platform and is raised or lowered by means of the foot controls. Inclination is managed through use of rollers on tracks, motivated by an electric motor, also connected to the foot controls. The rear section of the platform, on which the operator's stool and the controls are

The spotlight (at top in both pictures) is always focused on the mouth, as indicated by the crosses in the two photos, regardless of how much this new dental chair is tilted

mounted, can likewise be raised or lowered to place the operator at any level desired above or below the patient. The close-coupled operating range of the chair permits a more compact and pleasing location of accessories which, due to swivel arrangement of the stool, are always within easy reach of the operator.

CABLE GAS

Keeps Moisture Out, Sounds Automatic Alarm

WHAT if a tiny pin-hole should open and let a tiny drop of water get inside a telephone cable? This cable is the protective metal sheath enclosing the fine copper wires, in some cases as many as 4242 of them. The answer is that even slight moisture might cause short circuits and service interruptions.

But such troubles rarely happen, usually only if a violent storm, explosion, or accident causes a cable break. The reason is that a vast part of the telephone cables of this country, carrying in all some 100 million miles of wire, are charged with dry nitrogen, a harmless gas, which is kept there under pressure.

Should a leak develop, the escaping gas keeps other moisture out. Moreover, instruments on the cable detect the drop in pressure, sound an alarm at a nearby station, and indicate the approximate location of the break. A repair crew is quickly on its way.

BETTER GUN

Results from Use of Substitute Material

IN making an important piece for a heavy machine gun, a former automobile maker produced a casting to replace steel tubing. The purpose, of course, was to effect a large saving of alloy steel in the manufacture of thousands of machine guns. But it was found that use of the "substitute" also greatly reduced the production time and resulted in a unit of higher quality.

With the approval of Army Ordnance engineers, a sample was cast, machined, and assembled into a gun for testing.

"I kept my fingers crossed when the Army inspector took the gun into the cold room and began whacking at it with a heavy steel bar," says the automotive factory manager in relating the story of the development. "I thought he was not being impartial when I saw him hit the standard unit only twice and then wallop our experimental gun eight times; but, after he came

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A-6	Amp. Hrs. 225	Ea. 6.00
A-7	Amp. Hrs. 262	Ea. 7.00
A-8	Amp. Hrs. 300	Ea. 7.00
B-2(J-3)	Amp. Hrs. 37	Ea. 5.50
M-8	Amp. Hrs. 11	Ea. 2.00
L-20	Amp. Hrs. 13	Ea. 2.50
L-40	Amp. Hrs. 25	Pr. 4.00

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells..... $5.95

GLASS MERCURY TUBE SWITCHES

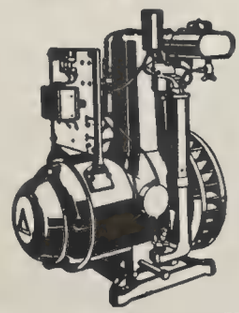
3 amp. ..... $1.25 10 amp. $2.25
6 amp. ..... 1.95 20 amp. 2.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.



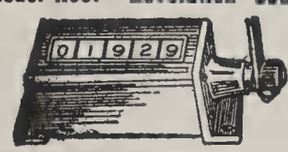
U. S. ARMY ALIDADES

Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. 45° angle adj. type, made in France $1.95

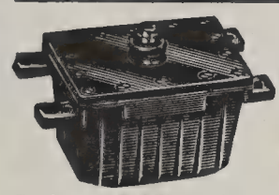
HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veedor-Root" Revolution Counter



Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50



TRANSMITTING CONDENSERS MICA

operating volts 12,500, cap. 004.
Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8.500. cap. 004 .....$7.50

NICHROME WIRE

in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound $18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound 15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound 10.50
Schwarze 8" 100 Ohm 32 volt 10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

Build Your Own Searchlight

U. S. Army Parabolic Mirror

Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	¼ in.	$15.
30 in.	12½ in.	7/16 in.	75.
36 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb to Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand.

BAROGRAPH, FRIEZE, 7 Day Graphic, 7 Jewel movement, 28 in. to 31 in. atmos. pressure by 20th. 8 Vacuum Cylinders 3⅝ in. dia. hinge cover, glass front, mahogany case. Price $55.00

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb. Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. ARMY LIQUID COMPASS (Sperry)

Bronze jewel bearing. Leather case. 2⅝" diameter, 1¼" high $2.50

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills $27.50
24-1000 Gen. Elec. 1000 mills $50.00
12-350 volt 80 mills $18.00
12-750 volt 200 mills 30.00
32-350 volt 80 mills 9.00
32-300 volt 60 mills 7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ⅝ inch wide $2.00

United States Govt. Fire Extinguishers

(Refillable)

Heavy Copper & Bronze

Carbon tetrachloride (pyrene liquid), pressure type, ideal for labs, trucks, boats, garages, office, etc. (10 times more pressure than hand extinguishers.) Just turn handle. No pumping necessary. Ideal for remote control with wire. (Original cost $40.00.)

1 qt. (100 lbs. pressure).....$10.50
2 qts. (200 lbs. pressure).....$16.50

TELEGRAPHIC TAPE RECORDER

Makes written record of code on paper tape. Ideal machine for learning code or teaching code to groups. Radio men can easily adapt it to short-wave receivers for taking permanent records of code messages. Double pen permits simultaneous recording of two messages. Pens operated by battery and key while tape feeder is spring driven. Made of solid brass on heavy iron base. Useful on fire, burglar alarm and watchman systems. May be used to intercept telephone dial calls. 10 ohms.

Rebuilt and finished,
like new $47.50 Reconditioned $30.

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

Plan for
"Duration" Living
NO SERVANT PROBLEM
NO TRANSPORTATION PROBLEM
NO OWNERSHIP PROBLEM
SCALED TO REDUCE COSTS, INCLUDING, IMPORTANTLY, COST OF MEALS
The Waldorf offers its "flexible-living" plan for 1942 on three different schedules:
ASTORIA APARTMENTS...one-room apartments that "live" like three rooms...for restricted budgets.
WALDORF ROOMS...large, homelike rooms and distinctive suites for individual or family living.
THE TOWERS...distinguished apartment-homes... 2 to 8 rooms...complete privacy...service pantries.
Astoria Apartments, Waldorf Rooms and homes in The Towers are serviced by The Waldorf's skilled staff...including many tried-and-true employees from the original Waldorf. Concrete and steel, The Waldorf is one of the staunchest buildings in New York. On guard day and night are trusted employees, all U. S. citizens...all bonded.
BOOKLET ON REQUEST
THE WALDORF-ASTORIA
PARK AVENUE · 49TH TO 50TH · NEW YORK

out of the cold room, he explained that the second blow had buckled the regular unit and that our cast substitute had come through undamaged."

Having won official approval, the substitution has effected larger savings of time and material than even its original proponents estimated.

The section of tubing which was replaced had weighed 20 pounds in the rough, and was whittled down in a series of machine operations which reduced it to a thin cylinder, pierced with many holes, and weighing less than five pounds.

In other words, manufacture of the part, as originally specified, required handling, machining, scrapping, transporting, and re-melting of three quarters of the steel in the original piece.

Refinement of the casting, on the other hand, sends only 1½ pounds of steel into the salvage bin. The reduction in man-hours required for machining alone is more than 45 percent. —*Automotive War Production.*

• • •

PLYWOOD—For appearance or economy, plywood panels are sometimes constructed with faces of one kind of wood and backs of another: For example, they may have a birch face for appearance, the rest of the plies of Douglas Fir.

• • •

PARACHUTE BOAT

Carries Much Equipment, Yet is Light In Weight

A NEW one-man parachute boat for emergency use on single-seater fighter planes has a total weight, including the 11 items of vital equipment that help protect the flier, of only twelve pounds. The boat is attached to the pilot as a seat pack when he is in the plane, is held tightly to him in parachute descent, and can be inflated in from five to ten seconds by turning a valve on a small CO_2 cylinder. First shipments of the new type boat have already been made by United States Rubber Company.

Advantages of the one-man parachute boat for speedy, small fighter planes are its light weight, great compactness and the fact that the boat always stays attached to the pilot.

Although this orange-yellow boat is 5 ft. 6 in. long by 3 ft. 4 in. wide when inflated, it folds into a compact seat pack only 14 by 15 by 4 in. Within this package is a full set of vital equipment. Two wire-reinforced fabric paddles fit the hands of the flier and are used to propel and steer the boat. A concertina hand pump is fastened to the inflation valve and can be used for maintaining required pressure.

The action of the pump, shown in use on our front cover, is similar to that employed when playing an accordion.

In case the boat should be pierced by machine-gun fire, the equipment includes special plugs the flier can quickly fasten into the holes made by bullets. If any accident should happen to the boat he has equipment for emergency use which he can use either working from within the boat or from in the water. In addition, he has a collapsible fabric bailing cup and a collapsible fabric sea anchor.

Total weight is only 12 pounds. In addition, the Government furnishes a can of water, and a sea marker for use by the flier in drawing attention for rescue purposes.

This new one-man parachute boat includes innovations developed by Fred Patten, boat expert of United States Rubber Company, working with basic British designs.

PHONOGRAPH FILTERS

Serve to Reduce Needle Scratch, Equalize Tone Values

USERS of electrical phonographs, either complete in themselves or attachments to radio receiver amplifiers, will find interest in two new devices recently designed to improve the playing qualities of such equipment. These units, one of them fixed and the other adjustable, are designed to be used with either magnetic or crystal pickups and to reduce to a minimum any annoying and unnecessary needle scratch. Furthermore, they can be used to alter the tonal range of the reproduction.

Needle scratch control is accomplished through the use of tuned filter circuits which by-pass the objectionable high-frequency noises from the amplifier circuit to the ground, leaving only the desired musical tones.

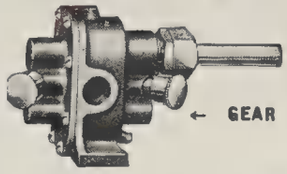
By means of other tuned circuits, control is exercised over the tone of reproduction. In the non-adjustable model of these units, manufactured by Gold Shield Products, tone equalization is obtained by switching connections to the proper binding posts. In this way, bass notes may be emphasized, or high fidelity reproduction may be obtained. In the adjustable model the needle scratch filter operates in the same manner as in the fixed unit, but the frequency response characteristics of any record may be varied at will by means of a special control knob.

The method of connecting either of these devices to any type of electrical phonograph is extremely simple and, the manufacturers state, anyone who can tune in a radio set can install and use one of them.

IMMEDIATE DELIVERY

LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

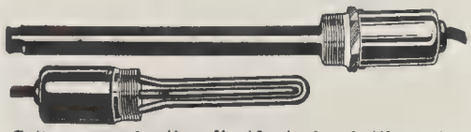
BRONZE GEAR AND CENTRIFUGAL PUMPS



		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	¼″	⅛″	$ 6.50	$25.00
No. 4	"	¾″	½″	13.50	32.00
No. 9	"	1¼″	1 ″	16.50	35.00

No.	1½	Gear	⅛″	Price	$ 9.00	With A.C. motor	$25.00
No.	2	"	¼″	"	10.00	" " "	27.50
No.	3	"	⅜″	"	11.50	" " "	28.50
No.	4	"	½″	"	12.50	" " "	32.00
No.	7	"	¾″	"	15.00	" " "	37.50
No.	9	"	1 ″	"	16.50	" " "	49.50
No.	11	"	1¼″	"	48.50	" " "	on request

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½″ iron pipe thread. Can be used on 110, 220 volt or 3 heat 110 volt.

600 Watt.....$7.50 1200 Watt $10.50
750 " ..... 7.50 2000 " 12.50
3000 Watt $15.00

DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	.....$1.10	20 Amp.	.....$3-15
3 Amp.	..... 1.65	35 Amp.	..... 5.50
5 Amp.	..... 1.65	65 Amp.	.....11.00
10 Amp.	..... 2.00	200 Amp.	.....50.00

AUTOMATIC CELLAR DRAINER

Prepare for rainy season. Keep your basement dry at all times. New improved Oberdorfer sump pump.

Pump built entirely of bronze, rust proof, long life.

Has Thermal Overload Device. Positively dependable and protects motor in case pump stalls.

Capacity 3,000 gallons per hour with ¼ h.p. motor at low operating cost.

Model B-2400 unit complete with 110 v., 60 cycle motor. **$37.50**

Unconditionally Guaranteed for One Year.

Literature Sent on Request.

CORDZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC. Only 10 watts. **$9.50**

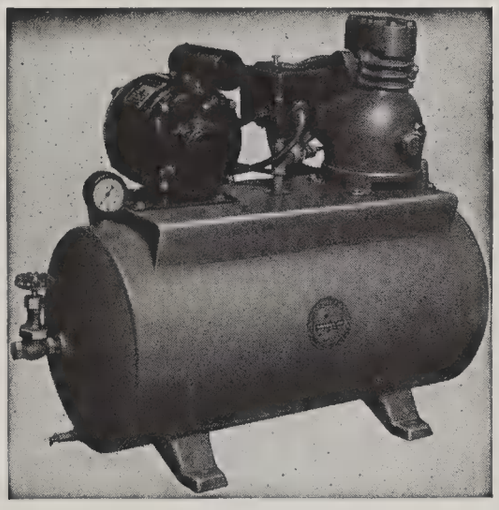
Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums. Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. **$7.95**

EXHAUST FANS, BUCKET BLADES
General Electric A.C. 110 volt motors.

	R.P.M.	cu. ft. per min.	Price
9″	1550	550	$12.00
10″	1500	550	13.50
12″	1750	800	18.00
16″	1750	1800	21.00
16″	1140	1650	27.50
18″	1750	2500	22.50
18″	1140	2100	32.00
20″	1140	2800	36.00
24″	1140	4000	42.00
24″	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.



HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12″ x 24″ tank A.C. 110 or 220 v. 60 cycle $57.50

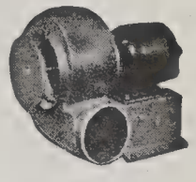
16″ x 30″ tank A.C. 110 or 220 v. 60 cycle $64.50

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4½″	3¾″	$22.00
0½	⅛	1750	350	6½″	3¾″	25.00
1	1/6	1750	535	6 ″	4½″	30.00
1¼	¼	1750	950	7½″	6 ″	37.50
1½	½	1750	1900	9½″	7 ″	75.00

PRICES QUOTED ARE FOR A.C. 110 V. 60 CYCLES ONLY.
OTHER VOLTAGES ON REQUEST.



PIONEER AIR COMPRESSOR CO., Inc.

120-s CHAMBERS ST. NEW YORK CITY, N. Y.

INVENTORS

FREE PATENT GUIDE

Take first step, without cost, toward protecting your invention. Write today for free RECORD OF INVENTION form to legally disclose your invention. We also send Free 48-page PATENT GUIDE containing instructions on how to patent and sell inventions; details of search services; easy payment plan; other interesting facts

CLARENCE A. O'BRIEN and HARVEY B. JACOBSON

24-K Adams Bldg., Washington, D. C.

REGISTERED PATENT ATTORNEYS

ARITH-MAGIC

Not a machine — BUT — a new theory of Mathematics — the greatest improvement in Arithmetic since the beginning of time. Solves all figure problems in 1/10 usual time and 1/10 usual effort. Infallible for accuracy and unequalled for speed. Postpaid $1.00 — Worth a hundred. Arith-Magic, Dept. 18, Maywood, Illinois.

Army Haversacks

heavy canvas, 7½ by 11 inches, with pockets, second hand, with leather sling. Postpaid for 75 cents. 1940 75th Anniversary catalog, 308 pages, 2000 illustrations, mailed for 50 cents. 1942 circular for 3c stamp.

Francis Bannerman Sons
501 Broadway, N. Y.

SMITH & WESSON

The World's Finest Revolvers Since 1854

SPRINGFIELD, MASS.

ALNICO MAGNETS

1" x 3/8" x 3/16"
2¼" x 3/8" x ½"

BARS 2 for 50c
1 for $1.50

LIFTERS — $2.00 — $3.00 — $4.00

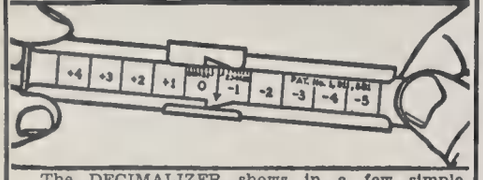
BLAN, 64-V3, Dey St., New York

Veeder-Root

COUNTERS for Every Purpose MECHANICAL-ELECTRICAL MANUAL

VEEDER-ROOT Inc., Hartford, Connecticut

The Morse Decimalizer



The DECIMALIZER shows in a few simple manipulations just where to place the decimal point in the result of any computation involving several elements, part or all of which may be decimals— for example, in such a problem as (9 ■ .0432 ■ 74.1 ■ 3.8) ÷ (245 x .0093 ■ 36). The DECIMALIZER removes that "decimal point hazard" inherent in computations made with the slide rule or otherwise.

Pocket size; durable (stainless steel); exceedingly smooth in action. Furnished in leather case, with complete directions for using. Price $2, postpaid; with extra, easily interchangeable scale which enables the instrument to perform extended multiplication and division, ■■ cents additional. Money back, if returned within 10 days.

GEORGE H. MORSE
927—28th Street South Arlington, Va

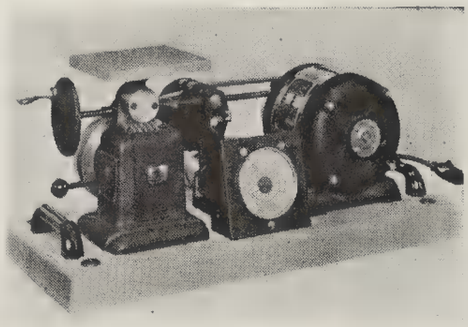
Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

DESTRUCTION TEST

Simplified by New Vibrating Equipment

DESIGNED for use in aircraft and industrial plants where there exists a need for testing products under conditions of vibration, a newly designed test table can be applied to determining the vibration resistance of a wide range of instruments, carburetors, control units of many types, and so on.



Variable vibrations

When the apparatus shown in one of our photographs is to be used in testing, the instrument or other equipment to be tested is firmly clamped to the six-inch square table. The drive will then impart vibration to the table in a vertical plane at variable speeds from 600 to 3600 cycles per minute over an amplitude range variable from zero to one-fourth inch. Both of these ranges are completely adjustable. It is claimed that the equipment will handle test work up to ten pounds maximum weight. Developed by Televiso Products Company, this testing device operates on 110-volt 60-cycle A.C.

THROW-AWAYS

Made of Plastic, Release Important Machinery

SCREW plugs, dummy plugs, cap plugs, and other devices are often used for the protection of hollow equipment or other articles from dirt, dust, and moisture while being handled or in transit. These plugs, commonly known as "throw-aways," have no functional value after the shipment reaches its destination. Formerly made of metal, and requiring the use of screw-machines, die-casting equipment, and other needed tools, these "throw-aways" are now being produced by American Molded Products Company from a tough plastic, thus releasing metal-working machinery for other and more important work.

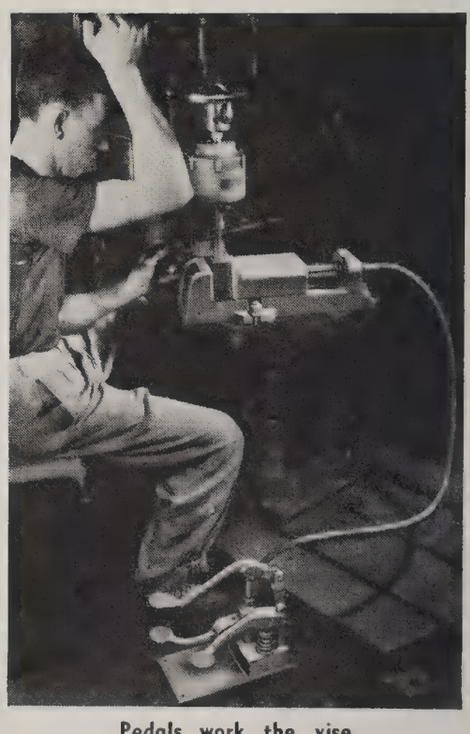
DRILL VISE

Operated Hydraulically by Pressure on Pedals

A NEW vise for use by tool and die makers, machinists and machine operators, and designed for holding work on the table of all types of drill presses, planers, shapers, milling machines, surface grinders, lathes, cut-off saws, and other machines, is called the Drilvise by its makers, the Studebaker Machine Company.

Entirely foot controlled and hydraulically operated, this new tool permits the use of both hands in the operation, set-up, and removal of work from the machine on which it is mounted. Exerting in excess of 10,000 pounds per square inch pressure between the jaws, this unit is ideally adapted for hundreds of machine shop uses.

Self-contained, requiring no outside power or air supply, the unit consists of a conventionally-shaped drill press vise (but without the usual screw or



Pedals work the vise

handle) and, connected to it by a six-foot length of flexible rubber tubing, a hydraulic foot control base. Parts are readily portable and can be easily moved from machine to machine.

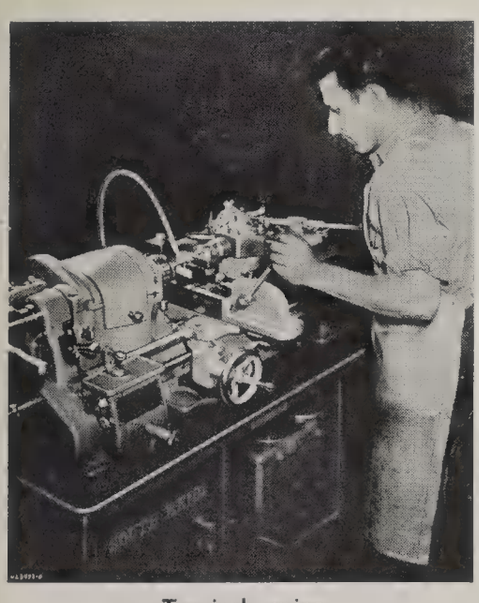
Work is placed between the open jaws of the vise, the operator moving the rear jaw toward the stationary front jaw by depressing the middle pedal of the foot control. This operation, taking only a second, moves the rear jaw against the work, exerting just the right amount of pressure to only grip the work. The right or booster pedal moves the jaw a maximum of 3/16" for each downward stroke of the foot and exerts a maximum non-slipping pressure of 10,000 pounds per square inch. To release work held between the jaws, the left pedal is depressed with one downward movement of the foot.

TURRET LATHE

Adaptable To Many Precision Jobs

A NEW bench model turret lathe for rapid production to close tolerances on chucking operations of bar works has just been announced by the South Bend Lathe Works. This lathe has a 10-inch swing over the bed and saddle wings, 1⅜-inch hole through the headstock spindle, and one-inch collet capacity. It is well adapted to second operation work.

The hand-lever operated bed turret indexes automatically and has an adjustable stop for each of the six turret faces. The lathe is equipped with both a compound rest cross slide and a hand-lever cross slide, which are interchangeable. The latter is furnished with front and rear tool blocks which provide three tool positions. A quick-change gear box supplies 48 longitudinal power feeds for the universal carriage, 48 power cross feeds for the compound rest cross slide and 48 thread-cutting feeds, 4 to 224 per inch. The underneath motor drive and back gears deliver 12 spindle speeds, from 97 to 700 revolutions per minute.

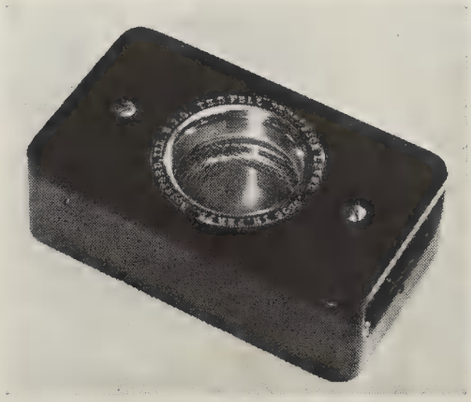


Ten-inch swing

LEVEL

Has Circular Bubble Which Accurately Shows Deviations

A NEW and compact level with which deviations in both longitudinal and lateral directions may be read on one setting has recently been announced by the William P. Fell Company.



Square scale shows deviations

The new unit, with a bearing surface 3½ by 6 inches, contains a gage glass 2⅜ inches in diameter. The indicating bubble, 1 5/16 inches in diameter, floats inside square graduation lines so spaced as to represent .0005 of an inch per foot of deviation from level.

RUBBER SUBSTITUTE

Made Practical by Use of Synthetic Wax

IN replacing rubber as a cloth backing in the manufacture of raincoats, life belts, and so on, the plastic material polyvinyl butyral has been used with considerable success. However, the characteristic surface tack of this material has to be eliminated without, of course, adversely affecting the other properties. It has been found that Acrawax C, a synthetic wax manufactured by the Glyco Products Company, Inc., when added to the polyvinyl butyral in amounts as low as 1 percent, effectively eliminates this surface tack. Furthermore, Acrawax C is a high melting point wax (275-280 degrees, Fahrenheit), non-brittle, water insoluble, and non-greasy. One percent is completely compatible with the plastic and shows no signs of blooming to the surface. It is available in powdered form and therefore can be readily incorporated with the other compounding ingredients in the milling operation.

1917 WAR RUN BY TELEPHONE

1942 WAR RUN BY RADIO

For Instance...

...during the battle of Midway the men in the radio room of an American aircraft carrier got a chuckle. They overheard two very excited Japanese talking—and they didn't sound happy . . .
(news item)

. . . there were 81 enemy bombers—swarms of fighters above and below...
. . . when they were spotted the call went out over the radio—
. . . the Marines piled into them.
(news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

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The Mighty Mars

Huge Cargo Planes Will Play a Leading Role in After-the-War World Economic Developments

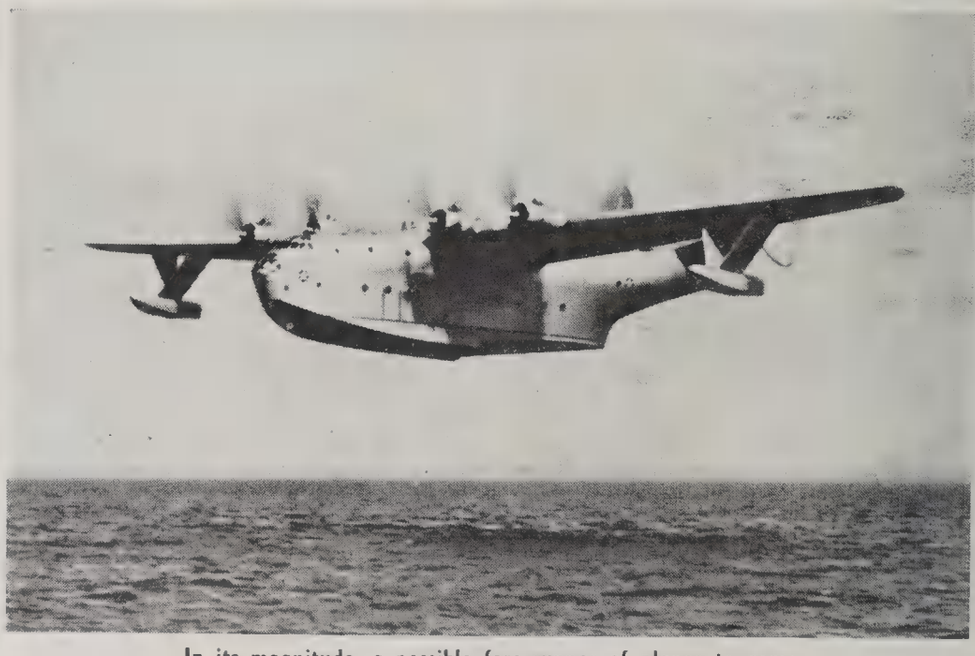
ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

To anyone who follows the press, the hearings before the Senate Committees investigating the possibility of our building huge cargo planes must be of considerable interest. We shall not enter into the argument nor attempt to analyze the statements of such authorities as Grover Loening, Eddie Rickenbacker, Henry J. Kaiser, and others. It is a very tempting idea to provide huge cargo aircraft, which will fly large loads rapidly to the outermost ends of the earth in a fraction of the time required by slow surface vessels, but there are two points on the other side. How quickly can we build such giant aircraft, and will the engines and other materials diverted to this task delay the construction of bombers and other fighting planes?

We are, however, able to present to our readers some preliminary information on the Mars, the huge new flying boat built by the Glenn L. Martin Company, prototypes of which are now under discussion for mass production. The Mars has recently made its first official flights, on behalf of the United States Navy, over the Chesapeake with complete success. With a wing span of 200 feet and a gross hull displacement of 995,000 pounds, the Mars could fly non-stop to Europe and back. Although rated as a patrol bomber, she can carry a large cargo, or, as a troop transport, 150 armed men. With such load-carrying capacities the proponents of the plan of building comparable boats in large numbers have some real ammunition with which to fight their battle.

The Mars is huge in every proportion. The cubic content of the hull is roughly that of a 15-room house. The crew can walk in the center portion of the wing to service the engines in flight. The four Wright Cyclone engines develop 2000 horsepower each and swing propellers 17½ feet in diameter. There is a spacious wardroom for officers and recreation space for the crew. The Commanding Officer has his own desk on the bridge and his own private stateroom. He can pace the bridge in flight in true sea-going fashion. There are two full decks throughout, a telephone exchange with 24 stations. Life aboard the Mars will be like life on a naval warship. The maximum normal weight of the ship will be 140,000 pounds, and the length overall is 117 feet, 3 inches. The height to the top of the hull is 24 feet. Sleeping accommodations will be available for 13 men. The gasoline capacity is enormous.

In one of our photographs the huge boat is in flight. The first impression



In its magnitude, a possible fore-runner of planes to come

we get is how closely the giant hull approaches the most desirable aerodynamic characteristics. The size of the hull is so vast that the landing step becomes almost insignificant. In the Boeing Ranger, another development in plane design, the tip float is mounted on a single cantilever strut; here we see two struts disposed at an angle providing for the bracing. The cockpit, or navigation room, blends beautifully into the rest of the hull. Twin rudders are employed. The rear portion of the hull rises cleanly upwards so that the tail surfaces are far from the water at all times. Tremendous skill and millions of engineering and shop hours go into the construction of the prototype of such a flying boat. Whether the Mars should be built now for war use is not for us to say. But we will go definitely on record that after the war such huge flying boats will make the Queen Elizabeth and the Normandie obsolete so far as first class over-ocean passengers and mail are concerned. Even as regards freight, the new seaplanes of this size will give surface vessels some stiff competition. It is not surprising that American Export Steamship Company has gone into the air transport business over the Atlantic, and that the Chairman of the Cunard Company, addressing his stockholders, speaks of his company giving consideration to the operation of flying boats after victory has been attained.

PLANE RANGE

Increase Is Desirable for Pursuit Ships

OUR bombers are the best in the world and wherever they appear we stand a fair chance of aerial supremacy. Moreover, our bombers have long range and can proceed under their own power to almost any quarter of the globe where they may be needed. The problem of delivery of the pursuit planes which may be needed to accompany the bombers, however, is not so easy, and a number of suggestions have been made for increasing their range.

One of these suggestions is to build a convertible monoplane-biplane. The biplane could carry a greater gasoline load than the monoplane, and the wings would be folded back into the fuselage when there was fighting to be done. Another suggestion is to use a biplane at the start and allow one of the wings to drop off when its duty had been done. Still another is to use an external gasoline tank of streamline form, to be jettisoned when the fuel in the tank had been exhausted. It is this last idea which is illustrated in the reproduced photograph of the Army Bell P-39 D *Airacobra*. The only change over the earlier production type is in the addition of the "belly tank."

The Airacobra carries a heavy cannon and is powered by an Allison V-type liquid-cooled engine, submerged behind the pilot's compartment. It is

One of several suggestions for increasing flying range: "belly tank"

connected to the hollow-hub propeller by a 10-foot drive shaft. It will be noted that the Bell fighter is equipped with a retractable nose wheel, and a movable canopy for the cockpit to the left in the photograph.—*A.K.*

JAP ENGINES

Analysis of Mitsubishi Kinsei Motor

OUR friends frequently ask whether Japanese planes and engines are really good. Mr. W. G. Ovens, of Wright Aeronautical, answers the question in a paper published in the *S.A.E. Journal,* entitled "Some Notes on Design Features of the Mitsubishi Kinsei Engine." This is a two-row engine of 14 cylinders, with a take-off power of 1050 H.P., apparently fairly comparable to one of our own engines and in excellent condition before it crashed. Mr. Ovens drew the following conclusions:

"'The engine is undoubtedly a highly dependable, even though not highly developed, piece of equipment, probably produced under time and tooling limitations which we would consider nearly impossible.'

"The designers 'did a very ingenious job of combining what they apparently believed to be the most desirable features of a number of foreign engines—proved features all—into a composite design that "has to work the first time," and probably did.'"

That certainly answers our friends' questions so far as engines are concerned.—A. K.

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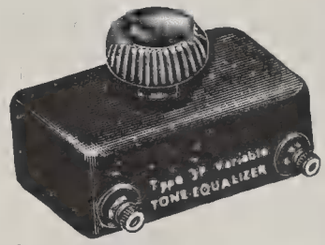

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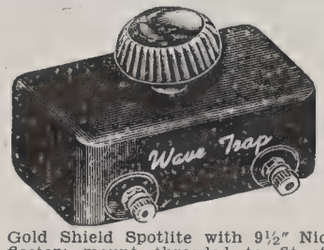

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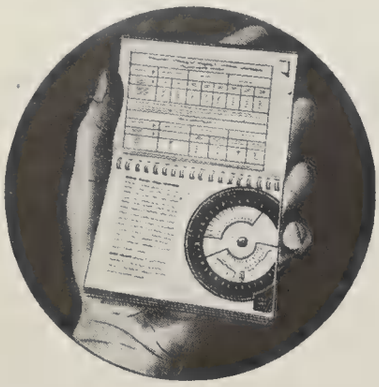

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Remember the rule that the angle of the incident light (the light source) is equal to the angle of reflection? A black surface will appear almost white if it is smooth, glossy, and the angle of the camera to the black surface is equal to the angle of the incident light. Changing the angle of the light source or that of the camera will minimize the reflection and substituting, where possible, a textured, matt surface for the smooth, glossy one, will break up the partnership even more effectively.

Better Than the Whole

Isolate a detail suggestive of the entire scene, and you often get a more impressive picture. This is particularly useful in a situation such as that illustrated. Folk dancers entertaining an outdoor audience had to be shot against a background of such distractions as those seen in one of the illustrations, or not at all. The composition was good, but the effect was greatly diminished by the busy background. A closer viewpoint produced the other picture, in which the distractions are largely eliminated by the rather drastic expedient of "eliminating" parts of the subjects as well! However, this major operation seemed appropriate to the photographer in this instance, for interest was focused chiefly on the leg movements. For when skirts fly and legs are revealed, where do *you* look? So do we!

Prints for the Service

With a couple of thousand prints already on display in 16 or more Army and Navy posts in the Third Corps Area and overseas Atlantic bases, the

Distractions eliminated

"The effect was greatly diminished by the busy background . . ."

Photographic Division of the Citizens Committee for the Army and Navy, Inc., is now in full sway. The shows, which are displayed in the day and recreation rooms of the posts, vary from 25 to 350 prints and enjoy not only the approval of morale officers but their active support as well.

Prints are solicited from the ranks of both the amateur and the professional, the best ones selected, and shows assembled to furnish representative salons of the finest work available in this country. In addition, the committee has assumed the responsibility of supplying the camps with the necessary hanging facilities. Members of the exhibit committee serve without remuneration and the funds required to defray the cost of display materials are contributed by individuals and groups. The presentations, which will continue for the duration, got off to a full start recently with a showing of 300 prints at Fort Hamilton.

Dustless Negatives

CONTRARY to popular belief, Augustus Wolfman says that a camel's-hair brush or a soft cloth are *not* the proper mediums for removing dust from negatives before enlarging. "While either of these items will brush the dust off the negative, they induce a static charge of electricity in the negative which attracts more dust, like a magnet attracts steel," he asserts. Moving the finger lightly across the film or blowing lightly will clear the surface of dust without "charging" the negative, he advises.

He suggests further that in removing fingerprints and grease marks from negatives, it is wrong to use carbon tetrachloride, as this, being a "dry" cleaner, has the same effect as using a camel's-hair brush. He therefore recommends the following "wet" cleaner as being most effective:

Film Cleaner

Ethyl Alcohol (pure grain alcohol)	85%
Methyl Alcohol (wood alcohol)	10%
Strong Ammonia Water	5%

Tinted Movies

MOVIE makers shooting black-and-white film have occasionally adopted the practice of placing a filter on the projection lens to obtain "color" movies. This method receives the stature of an accepted procedure with the introduction commercially of a set of four monochrome projection filters, "blue for snow and sea scenes, red glow for sunsets, green for masses of forest and lawns, mellow yellow for late afternoon and even to 'warm up' Kodachromes."

Small vs. Large Prints

THERE has been much ado among pictorialists recently on the subject of the proper size print to submit to exhibitions. The discussion has been precipitated by the growing number of 14 by 17's being submitted and the fact that the large prints generally win out over the smaller ones. One pictorialist even went so far as to refer to a 14 by 17 as a "normal" size enlargement. This was a little too much for the chaps who feel that they can just about afford 11 by 14's and would gladly come down to 8 by 10's if only the judges would not be prejudiced against their offerings on the count of small size.

So the discussion goes back and forth and self-righteous judges, claiming complete impartiality, say print size means nothing, only the picture counts; while exhibitors charge that judges lean to the big prints and are most impressed with them. J. Ghislain Lootens, a well-known judge and teacher, declared that the reason large prints win over the smaller ones is because the distance at which judges usually sit is about right for viewing the 14 by 17's but is prejudicial to the smaller ones. As a cure-all he suggested that prints of different sizes be viewed from different distances appropriate to the size of the print. The 1942 New York Salon of Photography adopted the idea and announced the fact in its entry blank. We shall see how it works out.

Using Etching Knife

MANY of the failures of beginners in using the etching knife, whether on negative or print, are due to the desire of the operator to get it over with as quickly as possible. As a result, the amateur holds the knife in such a way that the point digs the offending bit of emulsion out instead of merely *shaving* it off gently and gradually. This operation is easily accomplished, if you will be patient, by repeated applications of the knife at a narrow angle to the negative or paper base. With careful shaving, the black spot in the print can be eliminated without anyone being the wiser, and if too much is removed, leaving too light an area, it is a simple matter to spot it with pencil or spotting color. Shaving undesirable densities on a negative is a more difficult matter, but can be accomplished by persistence and some experience. It is wise, incidentally, to use different knives for negatives and prints, as the delicately sharp edge required by the former may be injured in working on the print.

Wall Paper Backgrounds

FOR something different in the way of backgrounds for your color shots indoors, try wallpaper for a change. You can use the paper already on the walls in your home, or get sample pieces. Backgrounds of any type are always something of a problem, but frequently they are very useful where unusual results are desired. In color work, you have the additional factor that the color of the paper should be harmonious with the colors worn by the subject. Also, the design must be "quiet," lending atmosphere to the picture but not stealing the show.

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METALLURGY

By Carl G. Johnson

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By William B. Ziff

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By Charles B. Norris

PLYWOOD demand is skyrocketing in the production of wartime housing, airplanes, boats, and other defense needs, yet specific information on the material itself is difficult to find. Here, between

the covers of a plastic-bound book, has been gathered technical information on all phases of plywood manufacture, specially written for engineers, designers, and users of plywood. (249 pages, 5 by 7½ inches, tables and drawings.)—$2.50 postpaid.—*A.P.P.*

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THE STORY OF THE AIRSHIP

By Hugh Allen

WHAT is the value of the non-rigid airships (blimps) that are becoming such a common sight in coastal areas of the United States? They appear to make ideal targets for enemy gunners, are relatively slow, and would seem to lack maneuverability. The author of the present book, long associated with lighter-than-aircraft operations, answers this and other questions which Americans are frequently asking. He tells of the advantages which the blimp holds for certain types of military operations, relates some of their history, shows how they have been improved since World War I, and presents the outstanding results of recent fleet operations. (74 pages, 6¼ by 9¼ inches, thoroughly illustrated with photographs and drawings.)—$1.10 postpaid.—*A.P.P.*

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GLUE, PLASTICS AND YOU, by I. F. Laucks, is a 16-page bulletin prepared in an attempt to lessen the confusion which now exists regarding the difference between the gluing art and the plastics art. *Laucks News Bureau, I. F. Laucks, Inc. Maritime Building, Seattle, Washington—Gratis.*

LATHE CATALOG NO. 16 is an eight-page pamphlet which describes a line of 16-inch Toolroom Lathes and 16-inch Quick Change Gear Lathes. Attachments, accessories, and tools for these lathes are also listed. *South Bend Lathe Works, Dept. S7, South Bend, Indiana.—Gratis.*

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STURDIMATIC HEAVY DUTY LIVE CENTERS is a four-page folder giving complete information and specifications regarding standard Morse taper live centers. Illustrated with photographs and drawings. *Sturdimatic Tool Company, 5224 Third Avenue, Detroit, Michigan.—Gratis.*

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METAL DUPLICATING WITHOUT DIES is a 32-page illustrated catalog describing in detail several mechanical devices designed specifically for duplicate forming of parts and pieces to die accuracy without the time delay and expense of die layouts and die sets. *O'Neil-Irwin Manufacturing Company, Minneapolis, Minnesota.—Gratis.*

CENTER SCOPE is a 20-page bulletin which gives instructions for using an optical tool to locate work to the center of a machine-tool spindle, to correct for run-out, and to locate layouts. Data are given on available models, edge block and table plug accessories, and typical set-ups. *Center Scope Instrument Company, 631 S. La Brea, Los Angeles, California.—Gratis.*

ACCIDENT FACTS—1942 EDITION is a 116-page statistical yearbook which gives most of the answers to safety problems. According to the National Safety Council, accidents—97 percent of them preventable—cost the nation $4,000,000,000 in 1941. This yearbook analyzes and presents statistics for the previous year and compares them with earlier years. *National Safety Council, Inc., 20 North Wacker Drive, Chicago, Illinois.—Gratis.*

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THE RATE OF OXIDATION OF COPPER, by Addison H. White and Lester H. Germer, is a study of the rate of reaction between copper and pure dry oxygen at room temperature and 20mm. pressure. The experimental technique is described in detail. *Bell Telephone Laboratories, Inc., 463 West Street, New York, New York.—Limited Free Distribution.*

TURNER TOPICS is a four-page folder devoted specifically to users of blow-torches, in an endeavor to enable them to get the maximum efficiency and service from these vital war tools. *The Turner Brass Works, Sycamore, Illinois.—Gratis.*

STEEL IN A YEAR OF WAR, by Walter S. Tower, is a summary of what has been accomplished in this industry during recent months, present problems, and a speculative look into the future. *American Iron and Steel Institute, 350 Fifth Avenue, New York, New York.—Gratis.*

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METAL is not in the same class with glass for optical surfaces. Your scribe recalls Professor Ritchey saying: "You can't put a real optical surface on metal."

Another man who had worked with both materials comments as follows:

"Glass—like all insulators of electricity—is no good mechanically; but it is homogeneous and it is seldom that a noticeable variation in hardness can be detected in any particular sample. Hence, when one piece is rubbed against another, with an abrasive between, it is to be expected that all parts of the same piece will be similarly affected by the same rubbing speed and pressure. Not so with the metals. The metal is composed of crystals and hence is of varying hardness. If the steel is tempered, the lack of uniformity of hardness is even more noticeable.

"The chances are that the metal mirror maker has two strikes on him before he even starts to work. The chap who uses glass can depend on what he is getting, and be reasonably sure that his next piece will be pretty much the same as the piece he is now using. However, metal is much easier to handle than glass.

"Steel," continues the same man, who wishes to remain anonymous, "cannot be ground disk on disk, because of the tendency to gall. Little pieces pick up and roll into large balls, making deep, torn furrows in the work. Hardened steel is much better in this respect. Hence, I grind and fine-grind the mild steels on a lead lap. The fringes soon become visible and I can almost finish the job on lead. Then a little polishing on pitch, with rouge, gives a gorgeous finish."

A man who has worked with metals for flats is Sydney J. Needs, The Fairfax, 43rd and Locust Streets, Philadelphia, Pa. He is not an amateur telescope maker but an engineer who was aided by "A.T.M." in learning to make metal flats for use in an extended non-optical but high precision mechanical research on boundary films of lubricant in machine bearings, an account of which he published in *The Transactions of the American Society of Mechanical Engineers*, May 1940, pages 331-345.

As he did not there include data on his method of working metal flats, he was invited to describe his technique for these columns. Much of his description will seem strange to the worker in glass but, since amateur opticians often are called on to do precision work on metal surfaces, the technique he developed after much laborious experimentation should go into the permanent record and not be lost. Your scribe has a neat little flat of hardened tool steel presented by Needs. It tests flatter than 1/20 wavelength—a millionth of an inch. Needs writes as follows, in describing his working technique:

"A metal surface produced by the lathe or grinder may be fine ground on a lead lap in preparation for the final polish. The lead lap has the advantages of being easily prepared; it wears away very slowly; and the degree of surface perfection produced may be varied within wide limits. In fact, the lead lap is capable of producing finishes quite satisfactory for most purposes without the necessity of further polishing.

"FOR work up to about 6" diameter, an 8" lap is ample. A lap of this diameter should be about 2" thick, but this thickness ratio is arbitrary and unnecessarily high for laps of larger diameter. The casting is prepared by melting lead of the purest and cleanest grade obtainable and pouring into an oversized wooden mold. To produce a good surface on the work it is necessary that the lap be free of foreign particles. For this reason, scrap lead should not be used. When machining the lead casting, the horizontal table of a small boring mill will be found preferable to the chuck or face plate of a lathe. The outside diameter and the upper face of the casting are finished in one setting. Half inch lifting holes about 1" deep may be drilled radially from opposite sides midway between the two faces. These holes are useful for holding the lap on the machine table, while the second face is machined parallel with the first, and are necessary for handling the lap when in use.

"Both sides of the lap may be used, one for coarse grades of Carborundum or emery, the better side being used with only the finest grade of abrasive.

"After machining, the faces of the lap should be scraped to fit a plane surface plate. Lead will be found very difficult to scrape, and a poor surface will result unless a few simple precautions are observed. The scraper used is the ordinary flat double-edged hand scraper forged from a discarded file and hardened. Time will be well spent stoning the cutting edges of the scraper until they are smooth and sharp. Lead is so soft that the scraper will remain sharp indefinitely. Place a piece of carpet or several opened newspapers on the bench to form a support for the lead lap. Moisten a clean cloth with lard oil and wipe the upper face of the lap. A thin film of lard oil will remain on the lead and, thus lubricated, the scraper will cut smoothly and without tearing the metal. Scrape the surface until all machine tool marks have been removed. Now clean both lap and surface plate thoroughly, moisten both with lard oil, and wipe dry with a clean cloth. A film of lard oil will remain on each and when the lap is gently rubbed on a surface plate, the trace of lard oil present will be sufficient to lubricate the points in contact. Upon removal of the lap these high points will be found brightly polished; and sufficient lard oil will still be present to lubricate the scraper removing them.

"After a test on the surface plate, remove all high spots, moving the scraper in one direction. After the next test, remove the high spots by moving the scraper at right angles to the previous direction, thus preventing the formation of furrows. Before each test clean the lap and reference plane thoroughly and apply a fresh film of lard oil; then remove as much of it as possible with a clean dry cloth. Should scratches be found on the lead after testing, more care in cleaning is probably indicated. When the contact spots are quite close together and well distributed over the surface of the lead, the lap will be found to float quite freely with no perceptible friction when first placed on the reference plane. This is due to a film of air separating the surfaces and an appreciable time is required for the air to escape. When this occurs, the lap is fairly flat, but the scraping may be carried on as long as patience will permit.

"ONE important detail concerning the use of the scraper must be added. Lead is so soft that merely reducing the pressure on the scraper at the end of a forward stroke is not sufficient to raise the scraping edge and stop the cutting. The scraper must be lifted from the work while still moving forward at the end of each stroke. If this is not done, each stroke will end below the surface of the surrounding metal and a burr will be raised where the scraper is stopped. The forward motion of the scraper removing the high spot has exposed metal, free of lard oil. If the scraper is moved back or a second forward stroke made over this unlubricated surface, scratching and tearing of the metal will result. The chip removed by the forward stroke will be found on the edge of the scraper and must be removed before the next stroke is started. After a few trials, the trick of raising the scraper and removing the chip with a finger will become automatic and require no further attention.

"After the scraping, the lead lap is ready to be charged and used. No grooves are necessary since the lap *is used dry*.

"For charging, a flat cast-iron plate is convenient, having approximately the same diameter as the lap but it need not be as thick. After it is machined all over, one side of the cast-iron plate is finished plane and smooth, either by scraping to fit the reference plane or by the time-honored process of grinding

three plates against each other in pairs. Lifting holes similar to those in the lead lap are drilled in the side of the cast-iron plate. To charge the lead lap, No. 600 Carborundum is sprinkled on its scraped surface and spread as evenly as possible with absorbent cotton. The cast-iron plate is gently placed on the lap and moved in several directions with short straight strokes. Ten or 15 strokes should suffice to spread the abrasive evenly and drive some of it into the surface of the lead. After removing the plate, all excess carbo is removed with a cloth and the lap is ready to use (with the work on top). At first the lap will cut rapidly but, after 40 or 50 strokes, recharging is necessary. Before recharging, however, much can be gained by rubbing the work over the cast-iron plate, since this also was charged when charging the lead lap. Being harder, the charged cast-iron plate will cut more rapidly than the lead lap, but the scratches in the work will be much deeper. By using the cast-iron plate and the lead lap on small work, the time required for removing the tool marks will be so short that there seems to be no advantage in using any of the coarser grades of abrasive. The lead lap produces a surface that is quite bright, and, almost from the start, the surface contour may be observed by interference fringes under a master glass.

"In addition to charging the lap, the cast-iron plate makes it possible to keep the work flat as the lapping proceeds. It has been found that, if the lead lap is flat, the work will be slightly convex, particularly if of small diameter. This is probably due to elastic deflections of the lap caused by the pressure applied to the work moving over it. To get the work flat, it is necessary that the lap be slightly convex. This is accomplished during charging by rubbing the cast-iron plate on the lead lap with the proper stroke. The plate will tend to become concave and the lap convex in the same manner as spherical mirrors ground by the telescope makers. Should the work become concave, the lap is too convex, and this is corrected during charging by reversing the process and rubbing the lap on the cast-iron plate. Thus surface control may be maintained during the process of the work.

"As soon as all tool marks have been removed from the work it is no longer necessary to use the cast-iron plate as a lap, and the finish is made on the lead.

"It is important that the lap be dusted free of all loose abrasive after each charging. The lap will cut faster when loose abrasive is present, but the edge of the work will be badly turned. When the abrasive is sprinkled on the lap, it will fall in small mounds. If these mounds are not broken up the cast-iron plate will be placed on several little hills and the local pressures over such small areas will be sufficient to distort the lead permanantly, causing humps to rise around the depressions. Hence, the necessity of spreading the abrasive as evenly as possible before using the cast-iron plate.

"As stated above, the lead lap cuts comparatively rapidly when freshly charged and it follows that the scratches in the work will then be deepest. When

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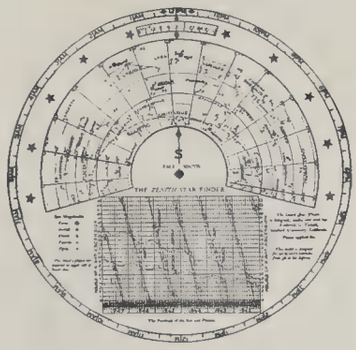

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TELESCOPTICS

all tool marks and visible flaws have been removed from the work and the test glass shows the surface to be of the required flatness, the polish may be considerably improved by continued working on the lead lap with no further recharging.

"From time to time, the lap should be washed with soap and water, washed again with clean water to remove as much of the soap as possible, and thoroughly dried with a clean cloth. Continued effort will reduce the depth of the scratches, with a corresponding improvement in polish. Unless removed mechanically or chemically, traces of soap will remain on the lap and these seem to assist by slightly lubricating the surfaces.

"The limit seems to be reached when the surface of the work begins to lose its brightness and take on a cloudy film. This is probably due to all the abrasive being forced into the surface of the lap, thus permitting the work to come into actual contact with lead. By stopping just before this point, the best results with the lead lap will have been achieved. Viewed through the low-power objective of the microscope at this time, the surface of the work is seen to be a mass of tiny scratches. The scratches, however, are very fine indeed and may be entirely removed in a few minutes by rouge on a pitch lap. If the pitch lap is flat at the beginning of the final operation, the polishing action on the work will be uniform and the surface contour unchanged by the pitch polisher."

With regard to metals for *optical* surfaces, Needs largely concurs with the anonymous writer first quoted, stating in the *Transactions A.S.M.E.* article cited above that: "There appears to be no metal which, when polished and examined even under low powers of the microscope, will present a surface of uniform surface even remotely approaching that of well-polished glass." If this is so decidedly the case, why then publish anything at all on the working technique for metals? Because of legitimate special uses for metal, and perhaps a little because of human nature. Amateurs will, and do, make metal mirrors.

Needs has told how he avoids turned edge without recourse to the exquisite skill developed by long-experienced makers of flats—simply the "surround" principle ("A.T.M.," page 53). "Turn up a ring (Figure 1) of the same material as used for the flat. Let the outside diameter be about 1" larger than the flat. Turn the outside of the flat a neat sliding fit in the ring. The fit must be good. If ever so little tight the flat and ring will both be sprung. If too loose, fine Carborundum will get between flat and ring and cause trouble when polishing. Heat gently and cement the flat in the ring with beeswax. Finish up, and the turned down edge will be on the ring. To separate, heat, push through hole *A*, and the ring will drop off, leaving the edge undisturbed."

SIXTEEN-INCH CLUB: In July, 1941, we told how Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, sponsored a "club" of amateurs who, if as many as 20 members could be rounded up, would get a greatly reduced price on 16" Pyrex disks; and in November, 1941, we told of the success of that attempt. We now bring the story up to date.

Some months ago Tombaugh gave us the names of 19 of the Sixteen-Inch Club "members," thus: Dr. C. O. Lampland, Flagstaff, Ariz.; Dr. James G. Baker, Harvard College Observatory, Cambridge, Mass.; Dr. H. Sidney Newcomer, New York; Messrs. John Kshir, 1702 Green St., Phila., Pa.; Harold Simmonds, 517 20th St., Sacramento, Calif.; Arthur Brear, 50 Willow St., Lawrence, Mass.;

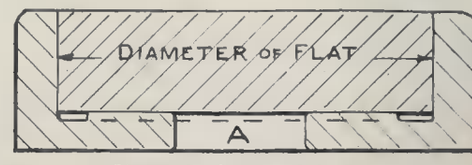

Figure 1: Surround for tde

Lyman H. Allen, 100 Franklin St., Boston, Mass.; Irvin H. Schroader, Angwin, Calif.; Byron S. Warner, 610 S. Reese Pl., Burbank, Calif.; Prof. Newton, Angwin, Calif.; W. L. Whitson, Washington Missionary College, Wash., D. C.; Harry A. Shaw, 2401 Mar Vista Ave., Altadena, Calif.; James J. Connors, 2318 S. 61st St., Cicero, Ill.; A. M. Mackintosh, 70 Arnold Rd., Jamaica, B.W.I.; Franklyn Creese, 269 Davis St., San Leandro, Calif.; Arthur Hugenberger, 2322 Kenworth Rd., Columbus, Ohio; Otto R. Griener, 55 Plane St., Newark, N. J.; Clyde Tombaugh, Flagstaff, Ariz. These ordered a total of 21 disks.

In August, Tombaugh wrote that the total had risen to 33 members and 37 disks, and of the former he knew of the following: Messrs. C. C. Taylor; B. L. Souther, 24 Harrison Ave., New Canaan, Conn.; H. A. Lower, 1032 Pennsylvania St., San Diego, Calif.; J. R. Smith; Russell S. Booker; C. H. Gamble; Marvin J. Vaun; J. W. Fecker; but did not know the addresses of some. "It would be nice if you could publish the list of buyers," he writes, "to keep interest alive. This club certainly exceeded my expectations. But I don't think I can do anything more with the Sixteen-Inch Club until the war is over, as I am organizing civilian defense and really am busy. After the war I hope to get the members organized into doing some serious observing."

Admittedly, the lists as given are far from complete or definite. Data are now difficult to round up, because of the war, and personnel is in a relative state of flux. The club has partly passed out of its original organizing control (it really never was a definite organization but a convenience to guarantee Corning the cost of a master mold). As word of the availability of this ideal size for a bigger-than-average telescope has got around, people have gone direct to Corning Glass Works, at Corning, N. Y. for the disks.

Those who build 16" telescopes are invited to keep in touch with this magazine and send in photographs and descriptions.

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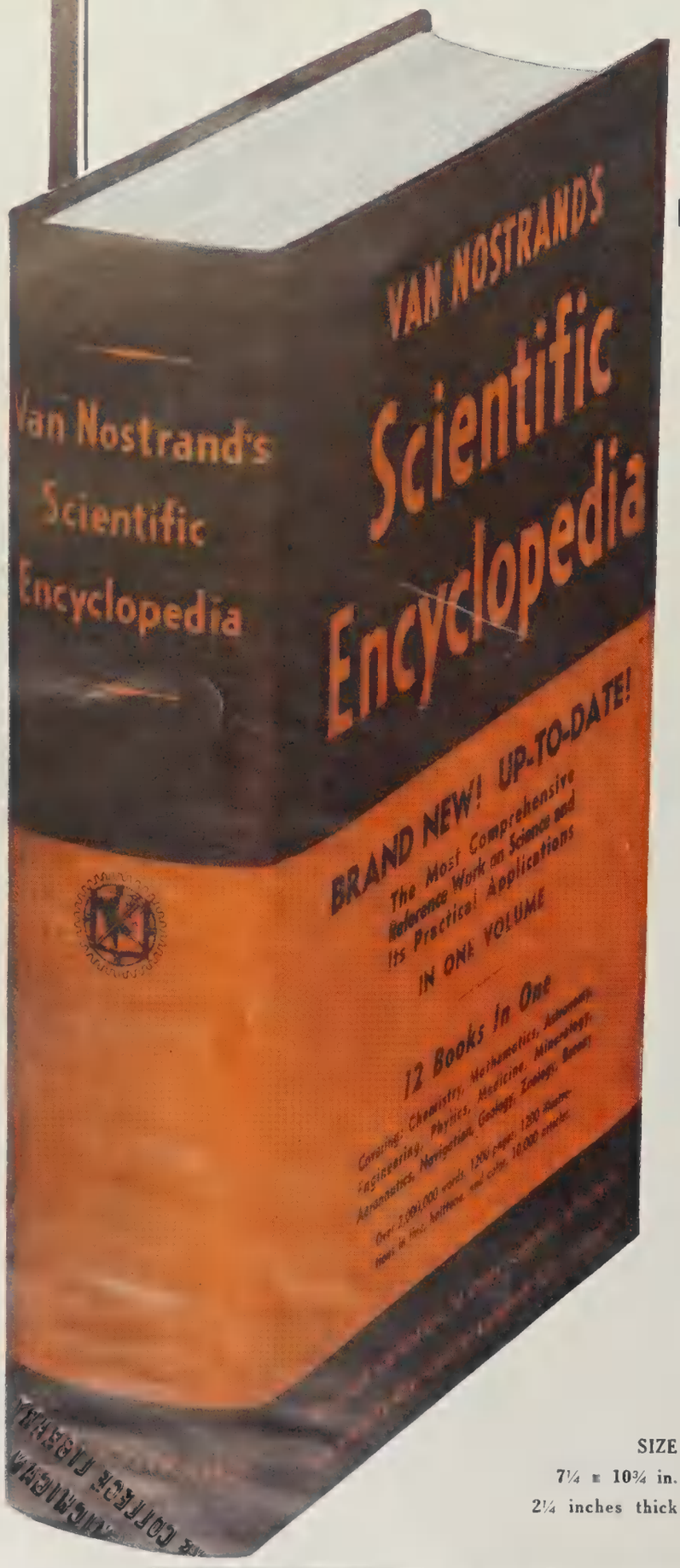
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50 Years Ago in . . .

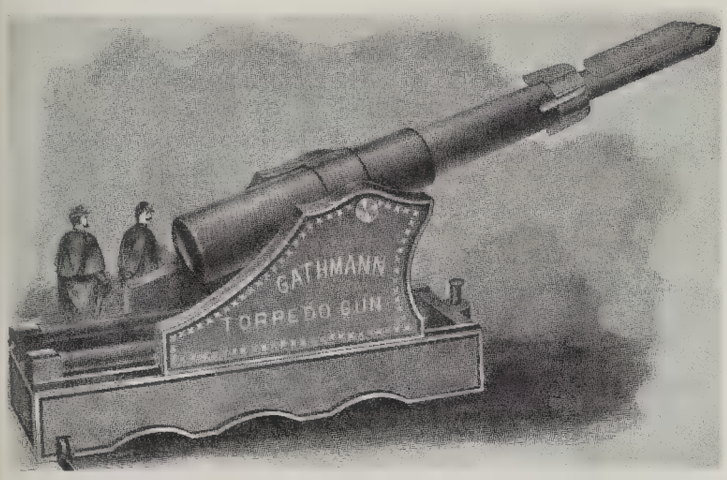
SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1892)

GAS ENGINE—"It has generally been supposed that gas engines were necessarily limited to 30 horse power and under, and that where larger engines are required they must necessarily be made by compounding smaller ones. . . . However, a large gas engine made by H. W. Caldwell & Son Company, is rated at 100 horse power. It is operated by carbureted air, consisting of a mixture of common air and gasoline vapor. This provides a fuel which is not only invariable in quality, but is quite inexpensive."

RAILROAD—"The highest railroad in the United States is the Colorado Midland, at the Continental Divide—11,530 feet above sea level."

TORPEDO—"A torpedo designed to be guided in its flight on leaving the gun after the manner of an arrow from the bow, and to continue its course on or near the surface, should it strike the water, is shown in the accompanying picture. The piece of ordnance for starting the torpedo is preferably a breech-loading gun, the torpedo being loaded in from the muzzle. . . . The shape and inclination of the wings are such as is designed to uphold and direct the projectile in a straight course through



the air, retaining it also near the surface after it strikes the water, until its propelling power is completely exhausted. In addition to the propelling force supplied by the gun at the time of discharge, in the usual manner, this torpedo is provided with further means of propulsion, concealed within the rear portion of its body, the combination being designed to give the projectile a great range and high speed through either the air or water. A 12-inch torpedo of this construction is adapted to carry 350 pounds of a high explosive."

GUN TRIALS—"Some rather surprising results were lately obtained with a new multicharge gun, of Haskell's pattern, half-inch bore. . . . A solid hammered wrought iron target, 7½ inches thick, was penetrated entirely through, backed by a boiler plate ⅜ of an inch thick, which was also penetrated through, making a penetration of 7⅞ inches. This shot was made of Carpenter steel, and the charges of powder were 10 ounces. This penetration is nearly sixteen times the diameter of the projectile, or more than four times greater than has ever been obtained by any other gun."

WIRE GLASS—"The subject of protecting glazed skylights is one which of late years has acquired additional importance. . . . In such structures as the Grand Central Depot in this city, light is given to the interior by large skylights. These are placed in the roof of the building and are of very large area. At a height of nearly a hundred feet above the floor they are a constant menace to life. . . . Wire glass, a substance designed to overcome these difficulties, consists of rolled glass, with iron wire netting embedded in its own substance. Thus the wire is hermetically inclosed, and is secure from corrosion for any length of time."

VOWEL STUDY—"At the recent International Congress of Physiology at Liege, Professor Hermann demonstrated his method of photographing the sound of vowels. The vowels were sung out before one of Edison's phonographs. Immediately afterward they were reproduced very slowly, and the vibrations recorded by a microphone. The latter was furnished with a mirror, which reflected the light of an electric lamp upon a registering cylinder, covered with sensitized paper and protected by another cylinder with a small opening which gave passage to the rays of light from the reflector. By this means was obtained very distinct photographic traces, and the constancy was remarkable for the different letters."

ARTIFICIAL RUBBER—"Isoprene, which can be prepared from turpentine, under certain circumstances changes into what appears to be genuine India rubber. . . . The same change could be brought about by heat. The material so produced resembles pure Para rubber in every way, and, whether it is genuine rubber or not, it may be equally good for all practical purposes. It is said to be capable of vulcanization."

MAGNETIC EFFECT?—"At the Edison Laboratory, Dr. Fred Peterson and A. E. Kennelly have sought to prove that no therapeutic effects are resultant from the application of magnetism to the human system. For the purpose of experiment the armature was taken from a dynamo, and in the cylinder formed by the inner ends of the set of powerful converging field magnets a dog was confined and kept for a period of five hours. . . . At the end of the time the dog was set at liberty, and beyond his apparent joy at thus being set loose the operation did not seem to affect him in the least. A boy was also confined for a short time in the same position and was also uninfluenced. Several other experiments of like nature were made. Dr. Peterson and Mr. Kennelly conclude from their experiments that the human organism is in nowise affected by the most powerful magnets known to modern science."

PHOTO CANE—"In a new photographic cane, the head forms a camera while the tubular body of the cane forms a reservoir for the sensitized celluloid strip. . . . In the cane head near the film is secured a plate, provided with a rectangular aperture through which the exposure is made. . . . The lens is placed in the cane head in proper relation to the exposed portion of the film."

YERKES—"By the munificence of Charles T. Yerkes, President of the North and West Chicago Street Railroads, the University of Chicago is to have a gigantic telescope. His instructions are to secure the largest and best telescope in the world, regardless of expense, and send the bill to him."

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'DOWN-UNDER' SHIPS OF THE NAVY

A Submarine Force of Unprecedented Striking Power

WALTON L. ROBINSON

SUBMARINES are among the most effective types of naval craft in existence. Striking without warning from their haunts beneath the surface, they have torpedoed and sunk millions of tons of merchant shipping and ended the career of many a proud battleship and cruiser. In the present conflict Germany's famed U-boats, operating in numbers and with a ruthlessness unknown even in World War I, have sent over 1500 United Nations and neutral merchant vessels to the bottom. They have also destroyed two British dreadnoughts, three aircraft carriers, several light cruisers, and numerous lesser units. Japanese, Italian, and Russian undersea craft have likewise operated successfully, while Britain's relatively few but highly efficient submarines have compiled a truly marvelous record in their attacks on Axis convoys and naval units off the Norwegian coast and in the Mediterranean. More recently American submarines, striking viciously at Japan's sea power in the Pacific, have sunk several of the Mikado's cruisers and destroyers and a large number of his troopships and supply vessels. One submarine, the *Seawolf*, sank one and probably two Japanese light cruisers, a destroyer, and a large transport, and damaged a third cruiser, a transport, and an unidentified ship—all in a single cruise!

On the outbreak of war with Japan the United States Navy possessed one of the largest and finest submarine forces in the world. Germany and Russia had many more undersea craft, but their boats were considerably smaller than ours and incapable of operating as far from base over an extended period. Japan also possessed a large number of submarines, many of which could cross the Pacific and operate off our west coast. Most Japanese submarines were somewhat larger than ours, but they have had only limited success against our warships and transports.

● Fifth of a series of analytical articles on ships of the United States Navy. Previous articles covered battleships, aircraft carriers, cruisers, destroyers, and appeared in our issues for May, August, September, and October of this year.—*The Editor*. ●

In December, 1941, a total of 111 American submarines were in service with 73 others under construction. Many additional boats have since been laid down, while still more will be commenced under the 200,000-ton increase approved by Congress last April. The submarines in service ranged in size from 480 to 2730 tons surface displacement and were of 12 distinct types, some composed of several classes varying in minor details. Forty-seven of our undersea craft—those completed since 1928—were of modern design. The remaining 64, commissioned between 1918 and 1926, still retained considerable value, particularly for training purposes. All of our submarines were painted black and carried their serial numbers in white on conning towers and bows.

SMALLEST and oldest of our submarines were the seven units of the "O" class, authorized in 1915 and placed in service three years later. Ten boats *(O 1-10)* originally comprised this class, but three were lost or scrapped. The *O 5*, wrecked in 1923, was salvaged, but not considered worth repair; *O 1* was converted into an experimental vessel in 1937 and scrapped the following year; *O 9* was lost June 20, 1941, by submerging beyond her safe diving limit, the pressure of the water crushing her old hull like an egg-shell.

The "O" boats are 172 1/3 feet long over-all and displace 480 tons in surface trim and 624 tons when submerged. On deck and forward of the conning tower they mount a 3-inch, 23-caliber anti-aircraft gun, while below the water-line in fixed positions in the bow are four torpedo tubes firing "tin fish" of 18-inch diameter. Eight torpedoes can be carried, four in the tubes and four in reserve. These submarines have two sets of 440-horsepower Diesels for surface cruising and two 370-horsepower electric motors for use when submerged. Current for the latter is supplied by storage batteries. On the surface a speed of 14.5 knots can be attained; while submerged, 11 knots is maximum. Cruising range is about 3000 miles. Each of these submarines is manned by 32 officers and enlisted men.

THE "O" boats were followed into service in 1918-19 by 20 units of the "R" class *(R 1-20)*. One of these, *R 8*, was scrapped in 1936 and another, *R 3*, was transferred to Britain late in 1941 and is now His Majesty's Submarine *P 511*. The "R" boats, measuring 186 feet in length and displacing 530 tons on the surface, are simply enlargements of the "O" design from which they differ principally in having a 50-caliber 3-inch gun and more powerful electric motors (two sets totaling 934 horsepower). Most of the "R" boats spent many years in reserve until recommissioned during 1940-41, but about six of them were always retained in service for training duties at the Submarine School, New London, Connecticut.

In 1919 the submarines *S 3* and *S 4*, first of a very numerous group, were placed in service. During 1920-25 they were followed by 49 additional "S" boats. Twelve units *(S 2-4, 6-10, 19,* and *49-51)* were scrapped during 1930-37; one, *S 5*, was lost in 1920; and another, *S 25*, was transferred to Britain last year and now serves as the Polish *Jastzrad*. Thirty-seven boats

were, therefore, still in service when hostilities with Japan commenced. One of them, *S 26*, was lost by collision off Panama in January last.

The "S" boats are of five types. The *S 1, S 18, S 20-24,* and *S 27-41,* all completed in 1920-24, are 219¼ feet long, displace 800 tons on the surface, mount one 4-inch, 50-caliber gun, and have four bow tubes firing 21-inch torpedoes. Eight reserve torpedoes, additional to the four in the tubes, can be carried. Two sets of 600-horsepower Diesels give a surface speed of 14.5 knots, and two 750-horsepower electric motors a submerged speed of 11 knots. About 45 officers and men comprise the complement of each of these submarines.

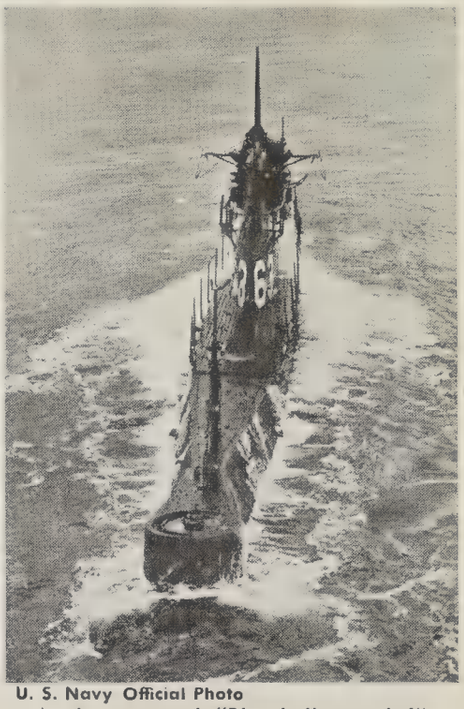
THE *S 11-13* displace only 790 tons, but are a half-knot faster on the surface, have an extra torpedo tube (located in the stern), and carry 14 torpedoes. They are engined with two sets of 1000-horsepower Diesels and two 600-horsepower electric motors. The *S 14-17,* also of 790 tons, have only four tubes, twelve torpedoes, and 14 knots speed.

The *S 48,* commissioned in 1922, is the largest of the "S" boats. She is 267 feet long, displaces 1000 tons, and is armed with a 4-inch gun and five torpedo tubes (four bow, one stern). Very handy for her size, she can "crash dive" in 60 seconds.

The last of the "S" series were commissioned in 1924-25, when the *S 42-47* entered service. They are 850-ton craft with armament and engines similar to those in the *S 1* group.

After the completion of the "S" boats, submarine construction in the United States dropped sharply, and only nine new undersea craft joined the fleet during the period 1925-34. With three exceptions, however, they were of remarkable size and cruising range. First of these boats were the *V 1, V 2,* and *V 3,* now the *Barracuda (B 1), Bass (B 2),* and *Bonita (B 3).* Built in 1921-26, they displace 2000 tons (2506 tons when submerged) and have an over-all length of 341½ feet. Their armament consists of a 3-inch, 50-caliber gun, six 21-inch torpedo tubes (four bow, two stern), and 10 reserve torpedoes. Diesels developing 6700-horsepower provide the surface motive power, but designed speed of 18.75 knots has never been realized in service. There are also two auxiliary Diesels which drive generators supplying current to the 2400-horsepower electric motors, which under this arrangement can be used for cruising on the surface without depleting the storage batteries. Radius of action is about 12,000 miles and submerged speed is 11 knots. A complement of 80 officers and men is required to operate each of these big submarines.

In 1928 the Navy commissioned its first mine-laying submarine, the 2710-ton *V 4,* which is now the *Argonaut (A 1).* When placed in service she was the largest undersea craft in the world, this distinction having previously been held by Britain's *X 1,* experimental giant of 2450 tons. The *Argonaut* was laid down in 1926 and cost about $6,000,000 to build. She is 381 feet long, displaces 4080 tons when submerged, and has a complement of 88 officers and men. Two 6-inch, 53-caliber guns are mounted fore and aft of the conning tower and four 21-inch torpedo tubes are in the bows. Aft is the mine-laying gear and stowage for 60 mines. The *Argonaut* was originally engined with 3175-horsepower Diesels designed to give a surface speed of 14.6 knots, but these engines proved unsatisfactory in service and new ones, incorporating Diesel-hydraulic drive, were recently installed. Submerged speed is 8 knots, obtained by 2400-horsepower electrically driven motors.



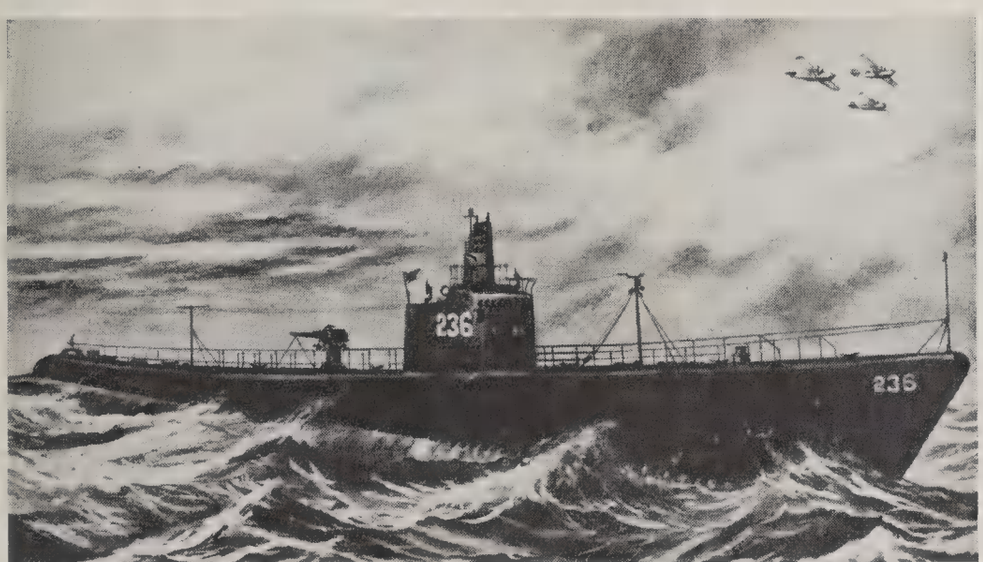
U. S. Navy Official Photo

At the command, "Blow ballast tanks!" this submarine training ship surfaced

The *Narwhal (N 1)* and *Nautilus (N 2),* commissioned in 1930, are of about the same size as the *Argonaut* and greatly resemble her in appearance. They are 20 tons heavier on the surface, but are not quite as long (371 feet) and displace only 3060 tons when submerged—120 tons less than the *Argonaut.* These three submarines are our largest and, since the loss early this year of the huge Free French *Surcouf* (2880 tons), the largest in the world. Laid down in 1926 as the *V5* and *V6,* the *Narwhal* and *Nautilus* have two 6-inch guns and four bow and two stern tubes. Eight reserve torpedoes can be carried; they are stowed externally under the half-deck amidships. These two submarines were completed with 5450-horsepower Diesels for a surface speed of 17 knots, but this was never realized in service and new engines were ordered in 1940. Electric motors of 2540 horsepower give a submerged speed of 8.5 knots.

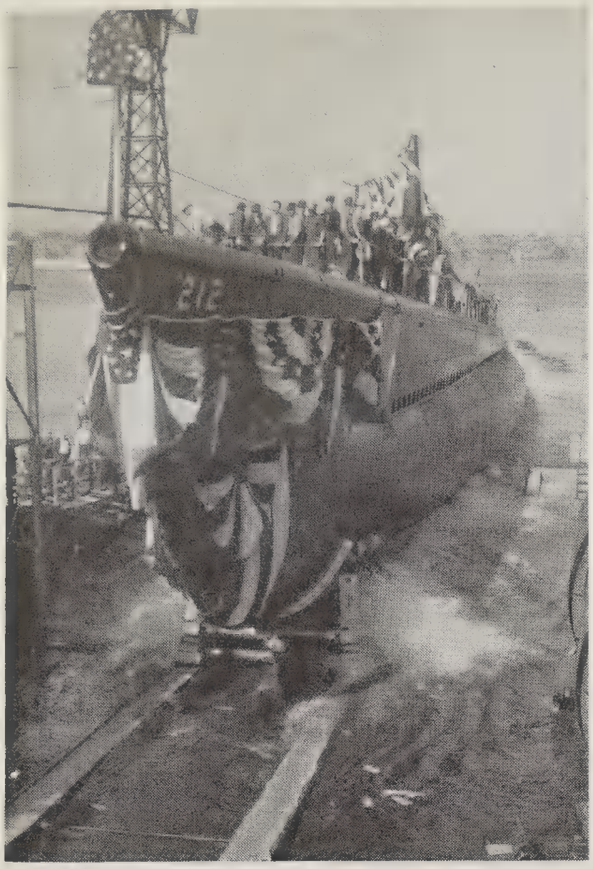
IN 1932 the *V 7,* now the *Dolphin (D 1),* was completed. Displacing only 1540 tons on the surface and 2215 tons submerged, she marked a distinct breakaway from the huge dimensions of the earlier "V's". Her over-all length is 319 feet and her armament consists of one 4-inch gun and six torpedo tubes, four bow and two stern. Three reserve torpedoes are stowed externally. Engined with 4200-horsepower Diesels and 1750-horsepower electric motors, the *Dolphin* can make 17 knots on the surface and 8 knots submerged. She requires a complement of 64 officers and men.

Last of the "V" boats were the *V 8*



U. S. Navy Official Photo

One of the *Albacore* class, authorized in the 1940 program



U. S. Navy Official Photo

The *Gato* goes down the ways to the sea

and *V 9*, now the *Cachalot (C 1)* and *Cuttlefish (C 2)*. Begun in 1931 and completed in 1933 and 1934 respectively, they were the first all-welded submarines built in the United States. The *Cachalot* (1110 tons surface displacement) and the *Cuttlefish* (1120 tons) differ from the *Dolphin* as much as she differs from the *Narwhal*. Only 271¾ feet long, they mount one 3-inch anti-aircraft gun *abaft* the conning tower and have four bow and two stern tubes. There is no external torpedo stowage. Surface speed is 17 knots (3100-horsepower Diesels) and submerged speed 9 knots (1600-horsepower electrics).

With the advent of the present administration in 1933, American submarine construction took a sudden spurt and during the period 1933-39 work was begun on 40 undersea craft, all of which were completed before Japan struck her Pearl Harbor blow. These submarines were of four distinct classes, three of which contained two or more groups varying slightly in minor details.

Ten "P" class submarines, authorized by the 1933 and 1934 Naval Building Programs, entered service in 1935-37. They were armed with a 3-inch gun abaft the conning tower and four bow and two stern torpedo tubes. Diesel engines of about 6000 horsepower gave them a surface speed of at least 20 knots. Radius of action approached 12,000 miles and cost averaged $2,400,000 exclusive of armament. This fleet of 10 submersibles included the 1310-ton *Pike* and *Porpoise*, the 1335-ton *Plunger* and *Pollack*, the 1315-ton *Shark* and *Tarpon*, and the 1330-ton *Perch*, *Pickerel*, *Permit*, and *Pompano*. Winton Diesels were in all boats except the *Plunger* and *Pollack*, which had Fairbanks-Morse, and the *Pompano* (Hooven, Owens and Rentschler). Six boats had Elliott electric motors; three, General Electric; and one, *Pompano*, Allis-Chalmers. Two of these submarines, *Shark* and *Perch*, were lost in the Far East early this year.

Sixteen submarines were authorized in 1935-36. They were simply enlargements of the "P" design with two additional torpedo tubes in the stern. The 1935 boats were the 1450-ton *Salmon*, *Seal*, and *Skipjack*, and the 1445-ton *Snapper*, *Stingray*, and *Sturgeon*. The 1936-37 boats were the *Sargo*, *Saury*, *Spearfish*, *Seadragon*, *Sealion*, *Sculpin*, *Squalus*, *Searaven*, *Seawolf*, and *Swordfish*. Displacing 1475 tons, they were slightly improved editions of the *Salmon* group, from which they differed principally in having somewhat larger conning towers and heavier periscope housings. Each cost about $5,000,000 fully equipped.

One of these "S" boats, the *Squalus*, foundered on diving trials May 23, 1939, but was subsequently raised and repaired; she is now in service as the *Sailfish*. Another, the *Sealion*, was undergoing repairs at the Cavite Navy Yard, Manilla, when hostilities broke out; she was badly damaged by air bombs and eventually had to be blown up to prevent her falling into enemy possession. She was our first submarine loss of the war.

The 1938 Program provided for six more submarines, the *Tambor*, *Tautog*, *Thresher*, *Triton*, *Trout*, and *Tuna*, all of which were completed in 1940-41. They displace 1525 tons, have a 3-inch gun, *six* bow and four stern tubes, and a designed speed of 21 knots, obtained by 6400-horsepower Diesels. They can be distinguished from the several preceding classes by their hull form, particularly at bow and stern.

Eight submarines were authorized by the 1939 Program and entered service two years later. These were the *Gar*, *Grampus*, *Grayback*, *Grayling*, *Grenadier*, and *Gudgeon*, all 1525 tonners, near duplicates of the *Tambor* design. The *Mackerel* and *Marlin*, however, are relatively small craft of an entirely new design. They displace only 800 tons on the surface, are 253 feet long, mount one 3-inch gun, and have four bow and two stern torpedo tubes. Their Diesel engines develop 1600 horsepower for an estimated 14.5 knots. Submerged speed is reported to be 11 knots.

All of the 73 submarines under construction prior to December 7 last were 1525-ton craft. The *Gato*, *Greenling*, *Grouper*, *Growler*, *Grunion*, and *Guardfish*, authorized by the regular 1940 Program, are slight modifications of the *Gar* design with two engine rooms instead of one to reduce the size of compartments. The *Gato* was commissioned just after Pearl Harbor; the others followed her into service within a few months. These "G" boats are the last of our "Alphabetical" submarines.

Sixty-five undersea craft were ordered under the War Emergency Program of 1940. Two more were ordered in April, 1941; 23 in the following December; and others since. The 1940 boats are of the *Albacore* class which is practically a copy of the *Gato* design. Ten of them are being built in the Middle West; they will proceed to sea via the Mississippi and fit out in Gulf ports. Some of the newer submarines may be modifications of the 800-ton *Mackerel* type.

The completion of the above submarines and of the many additional ones to be built under the 1942 Program will give the United States Navy an undersea force of unprecedented striking power and cruising range. We shall then be able to maintain numerous submarines on constant patrol off Japan's principal naval bases and along her vital lines of communication in the Southwestern Pacific. Such an undersea offensive will do much to cripple Japan's strength and hasten her downfall.

While this description of America's submarine fleet completes the originally announced series of five analytical articles on ships of the United States Navy, we now have under preparation two supplementary articles which, when approved for publication by the proper authorities, will cover, first, the air power of the Navy, and, second, the tactical usage of each branch of our naval fighting forces. We hope to have these available for publication soon.—The Editor.

What Is Being Done About Cancer?

Recent Experiments Begin to Give a Discernible Picture of Cancer's Cause, and Provide Methods

Research on cancer is pursued in many institutions the world over. Broad and significant is the research pursued at Memorial Hospital, New York. Outstanding is the accompanying account of that research, written for lay readers by Memorial's director, Dr. C. P. Rhoads, in the hospital's biennium report, "Record of Service," from which it is extracted.

Memorial Hospital is the pioneer American cancer hospital. In it, combined under one roof, are facilities for the treatment of every phase of cancer; also all equipment and facilities for cancer education and prevention, and, especially, cancer research. —*The Editors.*

THE body tissues are made up of quantities of cells, of which different types form different organs and body structures. When the normal body has reached its full growth, these cells stop increasing in number and, although they may die and continually be replaced by new ones, the replacement is held within the normal limits of body form. This control is exerted supposedly through the action of chemical processes which limit the rate of growth of the normal cells. Under specific conditions, however, some cells become immune to these chemical control processes provided by nature and are no longer subject to the growth restraint which handicaps the normal cells surrounding them. In this way the normal cells are overgrown and are killed by their inability to compete for nourishment. This overgrowth of uncontrollable tissue is called cancer. It seems clear, then, that the cancer cell, which is not susceptible to chemical control, must differ in chemical constitution from the normal cell, which is susceptible to control.

If a disease is due to uncontrolled malignant overgrowth, two possibilities for its cure exist: to render normal the abnormal cell, or to destroy that cell. The first possibility does not appear to be a likely one, since from all the evidence it appears that the malignant cell is irreversibly changed and can never be rendered normal again. The second possibility, that of destroying the malignant cell, is one already proved to be feasible by the vast amount of clinical experience with the partial destruction of cancer cells by X-ray and radium. These agents are only weakly effective, however, and better ones are required.

Research on the problem of cancer has been in progress for a great many years. A review of its progressive development serves to indicate its complexity and difficulty. The first method of attack was the application of morphological pathology, the science of the form of abnormal or diseased cells. This science made it possible to recognize, under the microscope, characteristics by which cancer cells can be differentiated from normal cells. The differences are of two types; one of shape, and the other of the affinities of the various types of cells and parts of the same cell for colored dyes.

The use of coloring brought into sharp relief the features of the affected cells. It revealed details, previously unknown, that clarified the way in which cancer destroys the body. Under the microscope, in a thin slice of an organ affected with cancer—the breast, for example—can be seen the finger-like processes of the parasitic cancer tissue invading and destroying the normal structure. It is perfectly apparent to any observer that the cancer destroys by its superior strength. In short, it wins a battle with the normal tissue—a battle which results in the destruction and dissolution of the defeated normal cells.

The ability of cancer tissue to outfight the structure of which the normal organ is composed has excited enormously the interest of scientists for over a century. From the appearance of the cancer cells, all sorts of deductions were drawn as to how the cancer cell gained its superior fighting ability, or, as expressed more commonly, its "malignant quality." The study of the form and staining qualities of the cancer cells became an invaluable tool by which various types of new growth could be distinguished one from the other. Once distinguished, the expected natural course, extent, and proper sort of treatment could be indicated.

IT was then observed that cancer developed in animals, and was indistinguishable in every respect from that occurring in man. Attempts were made to transfer animal cancer to normal animals. It was found that this could not be done unless closely related individuals of the same species were used as hosts. If such related subjects were available, some tumor tissue removed from the cancer-bearing animals could be inoculated into the closely related normal animals; it would grow and flourish, and could, in turn, be transplanted to other normal animals. The process could be continued indefinitely as long as related animals were employed in the experiments.

The proof of the transplantability of animal cancer was an important advance, since it indicated that, once a tissue cell has undergone the transformation into a cancer cell, it could be transplanted through an indefinite number of normal hosts and always remain a cancer cell. In other words, in cancer one deals with a mutation, or permanent alteration of the cell, which is reproduced through its offspring forever. This proved that it was hopeless to expect the return of cancer cells to normal. Clearly, then, in order to cure cancer, it was necessary to kill the affected cells, or to remove them from the body of the host.

A LITTLE later another advance was made. Peyton Rous showed that, in the case of tumors of fowls, the malignant tissue could be transplanted even though the affected tissue was ground up and passed through a filter which would not let cells through. The cell-free filtrate, when inoculated into normal fowls of the same species and strain, gave rise to cancer of the type from which the filtrate was devised. This proved that, in fowls at least, cancer could be caused by some part of the cell, and to this part the term agent or virus has been applied.

At this point two basic principles were apparent: 1) that of the abnormal form and staining qualities of the cancer cells, and 2) that of the transplantability of animal cancer. The next step required the development of an entirely new science, that of chemistry.

In 1756 Percival Pott conceived from pure clinical observation the unique idea that some cancer was due to tar. Later it was found that the application of tar to the ears of rabbits caused cancer. This experiment provided the possibility of isolating from tar and identifying the compound which caused the cancer. Two English chemists were finally successful in this attempt. They isolated from tar a few granules of a pure cancer-producing

substance and then many similar compounds could be quickly synthesized. The exact molecular structure required for cancer production was clearly delineated in this way.

At about this time the chemical nature of the compounds which are secreted as sex hormones by the body came under study. It was found that these compounds had a structure similar to the cancer-producing tar constituents. Furthermore, the injection into mice of certain human sex hormones resulted in cancer of the breast and other organs. Conversely, the injection of certain of the cancer-producing compounds caused sex changes in animals. Clearly, it was possible that cancer in man had to do with some improper or abnormal formation of sex hormones. The abnormal chemical manufacture might result in the formation, not only of normal sex hormones, but also of small amounts of "bad hormones," structurally allied substances which cause cancer. This possibility is considered to be so important that it warrants completely the serious investigation now in progress.

THE most recent experiments which bear on the cancer problem concern the effect of diet on the formation of chemically induced cancer in laboratory animals. The fact has been established that certain types of compounds will regularly cause cancer if they are administered while the animal is fed a diet lacking in certain vitamins and other food constituents. If these lacking constituents are added to the diet as supplements, and the administration of the chemical is continued, no cancer occurs. Obviously, in these experiments some food factor protects the animals against cancer.

The experiments described may seem to be unrelated and without application to the problem of cancer in man. As a matter of fact, the results now begin to form a discernible picture—one, to be sure, with many gaps, but still clearer than has ever been available heretofore. The picture is somewhat as follows: Something goes wrong with the manufacture in the body of those chemicals which are similar in structure to the sex hormones. The error in manufacture gives rise to small quantities of compounds which, by their structure, possess the power of changing normal cells into cancer cells.

This process of change is due to the ability of the chemical to interfere seriously with the life processes of normal cells. The cells are poisoned incompletely, and, in an attempt to live under these circumstances of chronic poisoning, they develop vital processes which are not affected adversely by the poisonous compound. In short, the cells become tough—so tough that they can compete successfully with normal cells in the race for nutrition. Then they destroy the normal tissues.

If we are satisfied to accept this hypothesis as the correct one—and its correctness seems to be attested to by

Memorial Hospital, New York City

the available evidence—another attack on the cancer problem may be at hand. One thing that could be done would be to examine carefully patients with cancer to see whether from their excreta we could isolate the abnormal hormone which caused the cancer. Perhaps in this way the difference in hormone formation between normal and cancer-bearing individuals could be distinguished. Perhaps the offending compound could be isolated and identified. If this were the case, undoubtedly we could develop methods for rendering normal the deranged hormone formation which led to the production of the poisonous cancer-producing substance.

This sounds like an easy task. On the contrary, it is one of the most difficult problems in modern chemistry. One example of the truth of this statement is the fact that the chemist who first described the chemical structure of the male hormones was able to isolate from thousands of gallons of urine about as much of the compound as could be placed upon the tip of a pencil.

At Memorial Hospital, with the help of Harvard University, we have had the temerity to attempt to isolate and identify all the compounds of this type in the urine of normal individuals and of individual patients with cancer. A number of new, hitherto undescribed substances have been isolated and are being identified. The existence of a difference as concerns these compounds in the urine of normal individuals and of cancer patients appears to have been demonstrated.

The study just indicated is an enormously expensive one, requiring a large staff of highly trained individuals, as well as a tremendous outlay for chemicals and equipment, but the reward is certainly worth the sacrifice. If an analysis of the urine of patients for the presence of these various hormone-like substances could be made, it might provide for medical investigation a technique of almost unimaginable scope. We feel confident that this will be the case, but it is not a matter of a few months or even a year or two.

A second line of investigation concerns the nutrition of cancer cells and of normal cells of similar origin. This may seem to be a fanciful type of study. It is not entirely so, however, since we know from our experience with the sulfanilamide type of drugs that one way of destroying foreign cells like bacteria is to starve them by withholding from them certain compounds which they require for nourishment. This can be done because bacteria—for example, the streptococci—are nourished by essential substances in their diet, exactly as the whole body of a human being is nourished by, and cannot survive without, food containing sufficient vitamins. Moreover, the requirement of these bacteria for food differs, certainly quantitatively, and almost certainly qualitatively, from those of normal tissue cells. In other words, by the administration of compounds, like sulfanilamide, it is possible partly to starve and to strangle (by an interference with the breathing mechanism) the bodies of bacteria causing disease. This can be done by concentrations of the drug which are not seriously poisonous and do not strangle markedly the normal tissue cells of which the body is composed.

IN view of what is known about the antibacterial drugs, it is clear that, in order to apply the same principle to the starvation, strangulation, and eventual destruction of cancer cells without exerting the same effect to the same degree on the normal cells of the body, one must know upon what substance cancer cells depend for their ability to breathe and to be nourished. This is a very difficult problem, but probably one not impossible of solution.

Two roads of attack are open: one, to measure exactly the requirement of the patient with cancer, as compared with the normal individual for essential dietary constituents. This is done by ascertaining the amount of these substances taken in and excreted in a given period of time, thus provid-

ing a level of nutritional balance. By the determination of such a balance, one can measure accurately amounts of food substances essential for different individuals.

A second method is the measurement of the amounts of essential or required dietary substances in the cells of normal organs and of cancer cells growing in the same organs. Suppose, for example, it were found that normal liver tissue contained a given number of units of a vitamin, whereas cancer tissue of the same liver contained and required a greater amount. We could then hope that the cancer could be destroyed by the institution of a deficiency of that vitamin.

The studies of nutritional balance have already provided information of interest and very possibly of eventual importance. The fact has been established, for example, that patients with cancer of the stomach have a strikingly disordered reserve of Vitamin A, the fat-soluble vitamin contained in cod-liver oil. It appears that, with the growth of cancer of the stomach, the ability of the body to store and to distribute vitamin A to its tissues is seriously impaired.

Even though enormous quantities of vitamin A are administered to the patients in an attempt to support in every way their general health and their ability to stand operation, it is very difficult to render normal their handling of this vitamin. This observation takes on even more importance in view of the fact, established last year and confirmed at Memorial Hospital laboratories, that the administration to animals of synthetic cancer-producing chemicals renders abnormal their handling of, and reaction to, Vitamin A. Indeed, a vitamin disturbance quite similar to that seen in human beings with cancer can be produced in these experimental animals.

NOT only is a disturbance of vitamin A found in patients with gastro-intestinal and other forms of cancer, but in leukemia, a cancer of the blood-forming cells, striking disturbances of the utilization and activity of another vitamin, thiamin, or vitamin B_1, have been shown in the Memorial Hospital laboratory, to be present. This demonstration required the development of entirely new methods of assaying the amount of the vitamin in very small amounts of tissue cells. The substance is measured in the affected cells, the leukocytes or white blood cells, themselves. Since the actual volume of these white blood cells in blood samples which can be removed safely from patients is comparatively small, extraordinarily delicate methods for vitamin measurement were required. When these were applied, a very interesting fact developed. The white blood cells of cancerous nature, leukemic cells, have a much higher content of vitamin B_1 (thiamin) than do any normal white blood cells examined.

In Memorial's child cancer department. Child cancer is not at all uncommon

This observation has been extended to show that the leukemia, or blood cancer cell, appears to possess chemical activities which are not different from those in the normal blood cell. Rapid progress is being made in our knowledge of these significant differences. We hope, by taking advantage of them, to be able specifically to injure or kill the cancerous blood cells without injury to its normal analogue.

Not only must we search for differences between the cancer and the normal cells, but we must also find points of similarity, since otherwise the differences would not be significant for our purposes of developing methods of cure. Differently expressed, if the amounts of some vitamins in cancer and normal cells were the same, but the amounts of other vitamins were strikingly different, one would feel more secure in attempting to use the difference as a route of attack. Such experiments are also in progress.

No conclusion can be drawn so far, except that the methods hitherto described for the measurement of vitamins in cancer appear to be somewhat unsatisfactory. If this seems to indicate that little progress has been made, the fact should be recalled that every one of these determinations requires the development of exceedingly difficult technical methods.

A third set of studies is in progress in an attempt possibly to short-circuit the more prolonged investigations and to develop a method of cure without exact knowledge of the mechanism by which the cure would be effected. This means a purely empiric study and such a one has been instituted. A method was devised by which the effect of compounds in poisoning cancer could be measured precisely. The experience with the chemical antibacterial agents, the sulfa compounds, in inducing the death of bacterial cells by their starvation, suggests, of course, that similar methods might be effective in killing cancer cells.

AS far as the experiments have gone, some 70 different compounds have been tested in the manner described. A type of chemical has been found which, in the test tube, appears to interfere with the health of one type of cancer cell of man—that found in cancer of the breast—and in the same concentration not to interfere with the well-being of any normal organ tissue so far tested.

The results may have a far-reaching significance. They prove apparently that there is a real difference between cancer cells and normal cells in their sensitivity to certain types of chemicals. The cancer is more sensitive and can be killed by compounds which do not kill the normal tissue. This observation alone is sufficient justification for the intensive continuation of the experiments.

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BORN THAT WAY

A Practical Solution for the Constitutionally Inadequate

"THE main trouble with many of the patients I see every day," says Dr. Walter C. Alvarez, noted stomach and intestinal specialist of the Mayo Clinic and author of the book "Nervous Indigestion," writing in *The Journal of*

the American Medical Association, "is that they are always weak and tired and full of pains and always getting sick in one way or another. Many have been operated on several times, but they still aren't well and they cannot get about and have fun as other people do.

"Again and again these patients go to some consultant or medical institution with the idea that this time they will get examined so thoroughly that the cause of all their troubles will be found and perhaps removed.

"Commonest among the diagnoses made nowadays in the hope of explaining the sufferings of these people are colitis, spastic colon, ptosis, pelvic disease, adhesions, chronic appendicitis, glandular dysfunction, low blood pressure, mild Addison's disease, low blood calcium, brucellosis, and chronic nervous exhaustion. That in a given case the diagnoses made in the past were wrong and the local abnormalities found were not sufficient to explain the illness can be seen from one fact alone, and this is that the extensive treatments carried out and the operations performed in an effort to correct the supposed diseases did not put an end to the symptoms.

"The question then is, How can matters be improved? It seems to me that, to begin with, we physicians must recognize more often and more promptly the constitutional frailness or sickliness of these patients and the inherent incurability of their disease. We must stop looking hopefully for some one lesion to explain the disability, the psychoneurosis, and the aches and pains everywhere, and we must not let ourselves be led astray by those little variants from normal that we can usually turn up during an examination.

"Treatment must consist mainly of keeping the patients from doing foolish things and wasting money. They must be taught, if possible, to acquiesce to the situation, to stop hunting for a complete cure, to hoard their energies, and to find a job that can be done without too much fatigue."

CHILD OUTLOOK

Mental Attitude Toward the Present War

CHILDREN between the ages of 7 and 13 reflect the cynical, disillusioned attitude prevalent just after World War I, with no positive idea of what we are fighting for this time, according to a study made on the Children's Ward by two Bellevue Hospital, New York, psychiatrists, Dr. Lauretta Bender and Dr. John Frosch.

The war so far has had no disturbing mental effect on these children, although they reacted with fear and anxiety to the threat of being separated from their parents. This conclusion, confirming British blitz experience, is reported by Dr. Bender and Dr. Frosch in the *American Journal of Orthopsychiatry.*

Although the children agreed that "war was bad," war has no very personal meaning to the average young child, according to these psychiatrists. Death and killing do not mean the same to them as to adults. In the few cases of anxiety over the war, this seemed to be due primarily to personal, emotional problems at home. "Glorification of war was conspicuous by its absence and surprisingly few thought of war in terms of bravery, heroism, freedom, and patriotism," these observers found. "If anything, there was a glorification of peace."

GERM KILLERS

Ultra-Violet Lamps Put To More New Uses

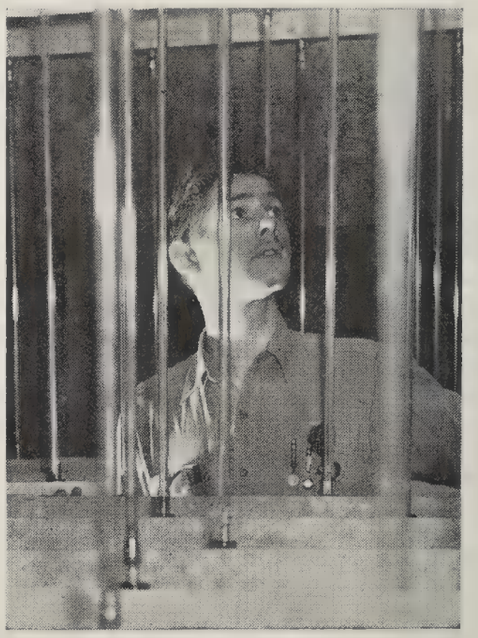
TWO new applications of the Westinghouse-developed Sterilamp, a source of ultra-violet radiation for germicidal purposes, have recently been put into practice. The principle of operation of

Electrical sterilization of footwear prevents spread of infection by shoes

the Sterilamp has been described previously in these columns, as have also various applications as developed.

First of these newest uses is to prevent foot infections being spread through the use of safety shoes in industry. In one of the Westinghouse plants approximately 1000 workmen buy steel-capped safety shoes every month, and most of them try on several pairs before making a selection. As one of our illustrations shows, those shoes which have been tried on and are to be put back in stock are first electrically sterilized by being placed over a U-shaped Sterilamp for from two to five minutes.

Second ultra-violet germicidal application recently announced is the use of these same lamps, but in larger



These ultraviolet ray lamps will help to purify the incoming air in ducts

sizes, to kill bacteria in air-conditioning air ducts. Another of our illustrations shows ultra-violet lamps arranged for this purpose. The air being drawn through the ducts passes over the surface of the lamps which are so staggered in placement as to stand guard over all of the passing air. It is claimed that such an installation will destroy 95 percent of the bacteria in the air passing through the duct.

JAP MALARIA

Scarcity of Atabrine May Cause Military Reverses

HIGHLIGHTS on how Chinese universities are carring on in spite of Japanese invasion and oppression were related at a recent meeting of the American Chemical Society by Prof. Clinton N. Laird of Lingnam University, who returned with Mrs. Laird on the *Gripsholm* after a wearing time while interned in Hong Kong.

Questioned about causes for the recent Japanese reverses and retirements, Prof. Laird said he thought one factor might be disease, especially malaria. The Japs depend more on atabrine than they do on quinine for treatment of malaria, and since their former bulk source of atabrine in Germany has been cut off they appear to be hard up for the drug.

Day After Tomorrow

A Continuation of the Report on How Industry is Planning Now for Peace-Time Operations

A. P. PECK

(In Two Parts—Part Two)

NEXT on the list of industrial executives to be questioned in the Scientific American industrial survey was Charles E. Wilson, president of General Electric Company.

"Obviously any plan for the post-war 'day after tomorrow' has to find its seed in yesterday," said Mr. Wilson. "This is particularly true, we feel, in the case of the electrical industry, in respect to both manufacturing and the distribution of power. The war effort has added tremendously, and is still adding to generating capacity. While the efficient use of these great amounts of electricity for the common good is primarily a problem for electric utility companies, it necessarily figures largely in the plans of equipment manufacturers such as General Electric, who build not only power-producing machines, but also the devices and appliances to use the power.

"There are two aspects of the 'war power' problem which are interesting to us," Mr. Wilson continued. "One is that existing central station installations are under a heavy strain—the turbines and generators and related equipment are being subjected to the severest kind of use and many of them may be worn out or have their operating efficiency seriously impaired. They will need to be replaced. The other aspect is that in certain sections of the country greater amounts of power will be available for use than ever before, once the emergency is past. Increased use of domestic home appliances, particularly for cooking and water-heating, will absorb part of this new capacity, but new industrial uses of electric power will also open up. There will be the need for modernization of plants to undertake new manufacturing tasks, and new methods of producing the highly competitive fabricated materials such as steel and aluminum will draw heavily on electric power. As we see it, these things all represent opportunities for post-war business — but opportunities in the sense that they must be planned for, sought out, and realized through aggressive action. They will not just fall into anybody's lap.

"There is still another aspect of post-war business planning that particularly concerns the electrical industry. We are proud of our war job with its vital production of needed weapons and tools. But more so than most industries, we have undertaken war tasks which flow most naturally from our particular talents. Most of the things we are making are electrical in character, and have to do with the generation, use, and control of electric power. Many of them are as applicable to peacetime as to wartime. The majority of the thousands of new employees we have taken on have been trained in tasks that need not necessarily cease when the conflict is over. Like most industries, we are acutely aware of the obligation which these added plants and added personnel imposes upon us, but we feel that we have a better-than-ordinary chance to keep them going afterwards.

"This industry has always had to face the so-called 'impossible'," said Mr. Wilson, "to seek an outlet for its talents and abilities beyond the horizon by means of original research and application. Our products, by and large, have not worn out; they have been made obsolete by the ambitions of scientists and engineers long before that. Therefore, to plan for the future is no new task. It seemed only natural that we should, from the beginning of the new world war, lay particular stress on the reconstruction years in our thinking and planning.

"Many months ago the General Electric Company set in motion a planning committee whose task it is to look into the laboratories for new ideas, to make preliminary surveys of potential markets, to inventory machines and plants and personnel. This was no visionary undertaking, and the detail in which some of these blueprints of the future operations have been drawn would surprise many outsiders.

"Complete as our plans may be," revealed Mr. Wilson, "we are aware that no one company, no single industry, can bring this off alone. It will require a broad and united effort on the part of all business. It will need an understanding of the risks involved for private enterprise, for we must gamble our bluest chips to ward off depression and economic chaos. We cannot sit back and be conservative and reactionary but must be prodigal with our time and our resources and our courage. Not only business is involved, but government and labor and agriculture as well. Because the scope of such an effort must be broad, we have tried to promote an interchange of ideas on planning and to set a good example.

"The pressure of war is tremendous, and its brighter side is that it has telescoped years of progress into months. Just as radio was a by-product of the last war, the plastics industry on a large scale seems to be a by-product of this one. It has been forced into an adult stage by government demands and the scarcity of other mate-

■ IN last month's issue were presented the views of executives of Westinghouse Electric and Manufacturing Company, Aluminum Company of America, and Lincoln Electric Company as revealed in answer to questions, the essential one of which was: To what extent are research, development, and invention, as prompted by war-time production, being correlated with plans for civilian production in post-war days? The questions were asked as part of a survey to determine for the American people what sort of a post-war world they may expect if industry is permitted to apply to its operations the fruits of present-day research and development.

Exigencies of space prevent repeating here the introductory and explanatory material published last month, and it is therefore suggested that readers who missed the first part of this article refer to page 151, October 1942 Scientific American.—*The Editor.* ■

Charles E. Wilson, General Electric: "Any plan for 'day after tomorrow' has to find its seed in yesterday"

rials. Electronics has made similar progress. Electricity will play a giant's part in the growth of the building industry after the war. On the one hand, consumer wants for the products of better living are being stored up, and on the other hand, those products are being improved by war-born knowledge. Any one can picture the post-war possibilities in aviation as a result of the new devices and instruments and controls developed for bombers and pursuit planes. The food we eat will be more nourishing, more plentiful, and better preserved and prepared as a result of work now going on.

"Fortunately, intelligent planning is a state of mind and not an activity which requires the labor of many men," concluded Mr. Wilson. "It is not inconsistent with maximum war production and need not get in the way of that all-important job. Yet it is tied to it as surely as tomorrow is tied to today. A mere handful of thinking men can ride the crest of research, development, engineering, manufacturing methods, and fundamental economics and shape a working plan for tomorrow. It may not be perfect and it is forever subject to change—but it is a plan. With it we need not face the future empty-handed and confused."

REPRESENTATIVE of the motor-truck industry is The White Motor Company, one of the country's largest manufacturers who are building motor vehicles for the armed forces—and at the same time learning many things that will be applied to the civilian motor truck of the future. Mr. F. T. Macrae, Jr., Executive Vice President of White, painted the following verbal picture:

"America recognized a long time ago that it might be drawn into the present conflict and it started marshalling its engineering and inventive genius to the task of turning out superior weapons. As evidence of work well done, we have highly efficient planes, tanks, trucks, and guns coming off the production lines today. With the best of equipment we will achieve victory—a victory with marked benefits for the peace-time era to follow.

"Not the least of the benefits to be derived will be the contribution of war tools to peace-time equipment, and certainly the influence will be most noticeable. Engineering and material progress has been so revolutionary that we can expect vast changes and improvements in many fields of human endeavor after the war is over.

"Quite naturally, the automotive and aeronautical fields will make use of the many developments precipitated by national defense," continued Mr. Macrae. "It is safe to say that some of these developments would have required 50 years or more without the driving force of war. Let us look at the strides we have made in the light of future significance.

"In the first place we have developed airplane engines of almost unbelievable power-to-weight ratios. This not only

F. T. Macrae, Jr., White Motor Company: "The finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared"

means far more efficient commercial airplanes in the future, but it means more efficient trucks, buses, and automobiles as well. Certainly the automotive field will inherit a great many things from aviation. As a matter of fact, some companies had already examined aeronautical standards before the war and had made better automotive products because of it.

"The White Motor Company went whole hog in adopting an airplane-type, air-cooled engine for its White Horse retail delivery unit as developed three years ago. And because of it, the company was able to boast unusual efficiency and economy of operation. White also took a tip from airplane design when it developed the Super Power engine for heavier duty units, thereby getting more power with less weight. But all this occurred before the present emergency period. The effect of World War II will be almost unlimited.

"For instance, farmers living in the vicinity of army camps have already witnessed the ease with which Half-Trac reconnaissance vehicles whisk across muddy fields and swamplands. And the question comes up: 'Why can't I get a vehicle like that for working my lowland acres?' When the war is over, that question will find friendly ears and designers will go to work to produce a domestic vehicle with all the operating advantages of the military unit.

"The Half-Tracs, as developed by White in collaboration with the United States Army Ordnance Department, are supported in the rear by a tractor belt. This gives them tremendous traction power on any kind of ground. With a wide range of gear ratios, these versatile units can vary their speed from a slow crawl in difficult spots to 50 miles an hour on hard ground or highway.

"This is but one example. Actually, the new tanks, planes, gun carriers, trucks, and other equipment will have a profound effect upon post-war operations. Soldiers home from the army will not forget the efficiency of mechanized military equipment and they will demand machinery of comparable efficiency for their peace-time work.

"When we look back, we can realize that World War I was the real birthplace of the airplane. When that conflict was over, commercial aviation came to the fore by leaps and bounds. Even the truck got its real impetus from that war. Obviously, where problems are forced upon us and competition adds its challenge, great things can be expected.

"The business world is already looking beyond the present conflict to the needs of the post-war period when defense employment gives way to domestic employment," concluded Mr. Macrae. "Certainly the finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared. And the path of design, dictated by wartime progress and invention, is a guarantee that radically new products will make their bid on the active market to come. In the same way, we can be sure that our present all-out production effort will leave its impression in the way of new and better manufacturing methods."

AND now a few words from the petroleum industry, as represented by Gulf Oil Corporation. Here the statement obtainable was short and rather evasive, but understandably so in view of the manner in which the oil industry finds itself at present between the devil and the deep-blue sea. Here is what Mr. C. H. Hathaway, Assistant to the President of Gulf, has to say:

"We are, of course, bending every effort in all divisions of our business—production, refining, and marketing—that will aid in the successful prosecution of the war. This includes re-

search in all of its various branches.

"It is both natural and inevitable that along with this we are gaging our sights, so far as we can look ahead, in anticipation of the conditions that will prevail in the following days of peace. Rightly enough, many of the things that war research and war planning are helping us to discover will not be without some benefit in the post-war period. Already we know this to be true. New and better products for the public and for industry must be one of the peace-time goals—products that will meet demands which in many cases may be quite different from those of the past."

WHILE everyone may not consider agriculture to be an industry in the generally accepted sense of the word, it is so rapidly assuming that status that some consideration of it must be given in any survey which attempts to anticipate the possibilities of winning the peace after the war. We therefore give the following quotations from a speech by Secretary of Agriculture Claude R. Wickard, presented at the Second Inter-American Conference of Agriculture in Mexico City.

"There will be need after the war for some of the stocks now piling up in this hemisphere," said Secretary Wickard. "European agriculture has been disorganized. There is starvation in occupied Russia, Greece, and Poland, serious malnutrition and undernourishment in every country Germany has subjugated. When this war ends, there will be immediate and desperate need for relief. The food supplies of the Americas can win the peace as well as the war.

"In the United States we welcome the changes in our agricultural plant which the war has compelled, for we believe the result will be a sounder agricultural economy. Many people of our nation have never eaten enough meat, milk, poultry, and fruits. There has been malnutrition, as in every other country of the world. I have seen similar reports prepared by Argentine, Bolivian, Ecuadorian, Colombian, Canadian, and Cuban nutritionists.

"The war now compels us to produce more of the very things our people most need. After the war our task will be, not to adjust production downward, but to find ways of distributing our maximum production to our people. Well-planned introduction of new crops to our hemisphere will give us more purchasing power, higher living standards, and a better basis for reciprocal trade.

"There is no serious contradiction between intensive war production and our desire to establish a sound post-war economy," continued Secretary Wickard. "Indeed, there would be little point to winning the war if we did not have positive plans and ambitions for the future. We are not so complacent about our pre-war way of life as to look forward only to its restoration. Few people of our nations would wish to fight for a return to unemployment, poverty, and hunger. Our fighting strength will be immeasurably greater if every man and woman of every nation has a stake in the war, and sees in victory a step toward a better world.

"We may expect other problems as a consequence of war. We are now beginning production in this hemisphere of crops such as rubber. What will our position be when other parts of the world can resume production and export? Some people have suggested that we cannot hope to compete with these areas because of the low wages paid there, and that continued production of such crops will have a depressing effect on real wages in this hemisphere.

"I do not regard that problem as impossible of solution, nor do I think we can permit it to deter our production

Claude R. Wickard, Secretary of Agriculture: "The willingness of free people to fight for a better future is the strongest weapon . . ."

efforts. First of all, we do not know what the post-war demand will be; the needs for rubber, metals, and other items may continue at better than pre-war levels. Further, there will be a period of adjustment, since other parts of the world cannot possibly resume full production as soon as the war ends.

"The real question, of course, is cost of production. The scientists and technicians may strengthen our competitive position by better production methods, higher yields, mechanization, improved transportation, and new processing techniques.

"Both for the present and the future, the United States Department of Agriculture offers to the representatives of other nations, and especially the nations of the Western Hemisphere, the services of its scientists, economists, engineers, and technicians, and the facilities of its laboratories and experiment stations. The United States Department of Agriculture has sent specialists to a number of countries to help solve livestock problems, cropping problems, economic problems, and problems of insect and disease control. Last year we sent a group of soil conservation experts to one of the southern nations to survey the agricultural land and recommend a program of soil protection and improvement. The men returned to the United States praising the co-operation they had received and the great foresight of the agricultural leaders with whom they worked. We have agreed to furnish similar assistance to several other countries.

"We would like to see a greater exchange of agricultural students between the United States and the other American countries. Young men from several South and Central American countries are now in the United States studying our rural electrification program. Other young men are studying our soil conservation program by working on the land with technicians of the Soil Conservation Service. Still others are being trained in agricultural economics by the Bureau of Agricultural Economics, and a number have accepted scholarships in agricultural chemistry and engineering. We hope these training programs will be expanded. I think there is still much to be done to promote the exchange of information and ideas. The Inter-American Institute and the new experiment stations will provide new opportunities for American scientists and technicians to combine their knowledge and skill.

"Together we can map out a future for agriculture, a future of progress and economic well-being," concluded the Secretary. "We can offer to our peoples and those of other lands a better way of living. In fact, we must do so, for our war effort depends upon it. The willingness of free people to fight for a better future is the strongest weapon of the United Nations."

FROM agriculture to tool engineers is the next and last step in this survey. The skill and ability of America's tool engineers which have made possible the rapid conversion of industry

to war production will, in peace time, bring to America mass-produced commercial planes and a new type of automobile with a much smaller and higher compression motor, according to Frank W. Curtis, Chief Engineer, Van Norman Machine Tool Company. Jigs, fixtures, dies, and other forms of special equipment, the products of tool engineering, are the measuring stick of success in modern industrial war production, instead of being merely the overhead evil they were formerly considered, Mr. Curtis declared, and continued:

"The war efforts have resulted in the development of processes and products that otherwise might have been delayed. After the war, it will be another problem for the tool engineer to make it possible for these discoveries to be applied and made available for public consumption.

"Automobiles and airplanes are two outstanding products that will derive the benefit of scientific research and thus create a vast number of changes in our way of life. Just what the automotive engineer will do after the war is still a secret, but it is safe to assume that the industry will be reborn, as will many others.

"America's increased capacity in the production of aluminum and magnesium will bring about a tremendous expansion in the use of light metals for automobile uses. These metals will, no doubt, compete with steel for many purposes. Plastic materials will be available in larger quantities than ever, and automobile bodies of plastics are quite possible to conceive. Plastics capable of withstanding heavy blows are already available for many war uses and will find even more uses in peace-time.

"A refined gasoline many times more powerful than our present fuels has been produced, which will require entirely new automobile engines because present designs are not able to use it. This fuel is of a very high compression type that will require a small, high-speed motor with greater power per pound of weight than present motors.

"Since airplanes depend on lightweight motors, these engines will probably be used in the larger number of small planes that will be produced after the war, so that a new era of civilian flying can be expected, especially with the thousands of army and navy trained pilots who will want low-cost aircraft of their own. The rapid strides made in the building of warplanes have been made possible only under war emergencies, where speed has been so urgent. The mass-production methods will carry over to peace-time, so that we may expect the air to rival the road as a means of travel.

"Tool engineering has had an enormous effect upon nearly every phase of the advancement of civilization," Mr. Curtis explained. "The cost of automobiles, refrigerators, radios, and many other products would have been far beyond the reach of the average man if it were not for the science of

Frank W. Curtis, Van Norman Machine Tool Company: "After the war it will be . . . for the tool engineer to make it possible for . . . discoveries to be applied"

tool engineering. Not many years ago, interchangeability of parts was considered an expensive undertaking, limited to the manufacture of products in exceptionally large quantities. Today, however, through the close study of manufacturing methods, almost any type or style of product can be made interchangeably, even though the output may be considered relatively small.

"During the past few years management has learned that tool engineering is the backbone of successful manufacture. Not so long ago, however, some executives were not too familiar with the so-called hidden advantages of 'tooling', and looked upon special equipment as some kind of unnecessary overhead that merely 'cost a lot of money.' Today, the picture is quite different. 'Tooling' has become of vital importance, and management realizes how necessary it is to tool-up adequately to meet production demands within stipulated costs.

"Those engaged in the field of tool engineering know, perhaps better than anyone else, that tooling cannot be valued by its cost. Cost is a factor, of course, but performance is what counts and what we must attain if our tooling is to be succesful. Let us not forget that more can be accomplished with highly specialized tooling in a machine tool of an earlier model, than through the use of a most efficient and modern machine with inadequate tooling: something that could be likened to 'hitching a race horse to a plow.'

"When a design or an idea is born, we should first look to the tool engineer to offer his final analysis of whether or not the product can be successfully made. In plants where this practice has been adopted, the tool engineer has the opportunity to analyze the product from a production viewpoint, and without any selfish motive whatever can be very instrumental in showing how certain changes and modifications can be made to eliminate expenses and costs which might otherwise be overlooked. Often the product can be picked apart, piece-by-piece, enabling redesign, if necessary, to conform with modern day manufacturing practices.

"We should always remember that the design of a product is one thing, and the method of making it is another," concluded Mr. Curtis. "Both must tie in with each other, because any product, no matter how efficient it may appear, is no better than the tools used for its manufacture. The tool engineer, therefore, is as important in our industrial cog as the designer, who is called upon to develop a product, because without tools and a means of producing economically the most needed type of product would be restricted."

Thus, as Mr. Curtis so ably points out, the part of the tool engineer in shaping the future of the world is more assured now than ever before; the more rapidly tools can be produced, the sooner industry can turn from one product to another, from a crude design to a perfected unit, from old styles to new. Such rapidity of change-over, with resulting economies, will be an essential in the shift from war production to production for peace.

Upon such men as those quoted in this survey depends the future of industrial America, a future that will be assured in proportion to the speed and efficiency with which these same men complete their war-time production job. Their mental processes have been sufficiently revealed here, it is believed, to demonstrate beyond doubt that, given an even break to apply their know-how, the men of industry in the United States will do more than their share toward winning the war. Once this is accomplished, they will plunge just as enthusiastically into the winning of the peace, prepared for the

work of tomorrow by the foresighted planning that was a continuing process during the war-clouded times of today.

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SILVER LININGS

Are Being Proved Industrially Practicable

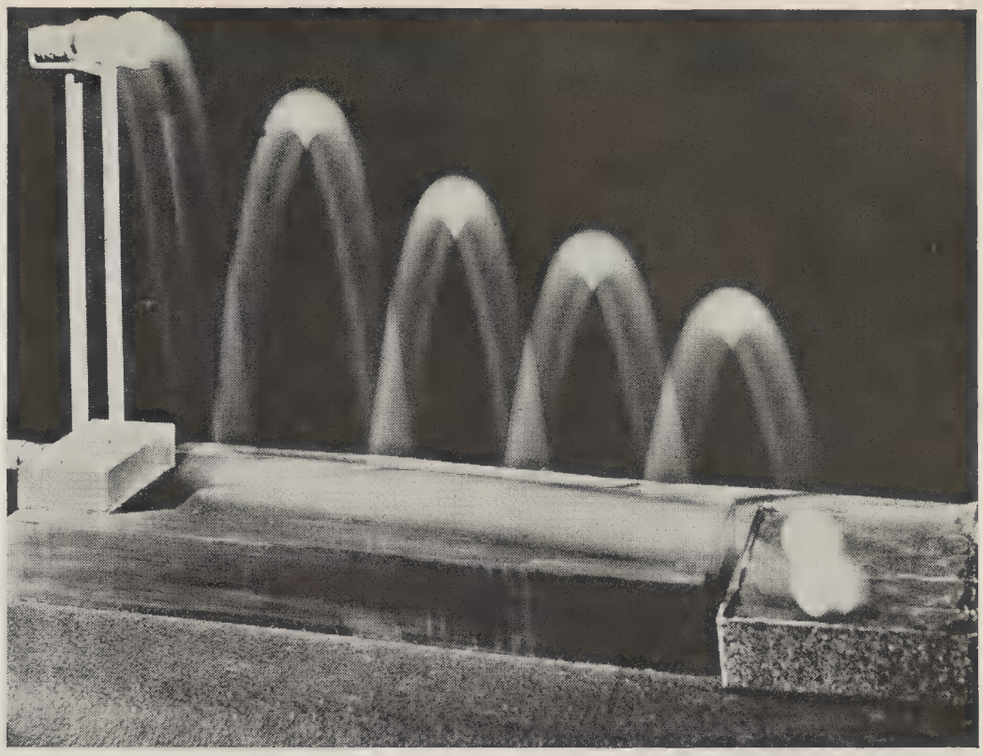
THE present-day tin can has been and continues to be a satisfactory metallic container for a vast number of purposes. Today, however, although we are faced with a dire shortage of this seemingly indispensable coating metal, we have at hand another metal —silver—which can be substituted for tin as a container lining with the outstanding advantage that it is resistant to many products which attack tin.

Silver is resistant to alkalies, organic acids, and certain concentrations of hydrochloric and other mineral acids. Most organic silver salts are free from color, thus eliminating the objectionable discoloration of contents, even though traces of the silver may be dissolved. For that reason, silver has long found wide use for a variety of equipment in chemical manufacturing plants. Silver is also bactericidal and may be used in contact with food, and may even be taken into the body in minute quantities without danger. Obviously, therefore, silver is eminently fitted for the linings of containers of such products.

Silver can be applied relatively economically to metal containers by electro-deposition on the sheet which can then be formed, soldered, and so on. It can be applied from the very thinnest deposits (0.0001 of an inch) up to very heavy thicknesses (0.05 of an inch) with equal facility. It has also been deposited, under laboratory conditions, at very high current densities up to 200 amperes per square foot, thus pointing the way to reductions in the time of "dwell" in the electroplating bath to a fraction of common practice.

The cost of silver plating depends upon, among other factors, the weight of the silver deposited: cost, approximately 28 cents per square foot for 0.001 of an inch thickness. From this should be deducted the cost of the material which it replaces such as: nickel at 2.5 cents for the same thickness, copper at 1 cent, tin at 2.5 cents and so on.

Interest in the use of silver-lined containers may be judged from the fact that they are being considered seriously for such products as foodstuffs, high-grade beverages, beer, cola syrup concentrates, condensed milk, evaporated milk, salves and other antiseptic materials, ether, aluminum chloride, and other chemicals.



Failure to bounce indicated a way to progress in electrical relays

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WOOD BENDING—Wood treated with urea or carbamide, and heated to about 225 degrees, Fahrenheit, can be bent or molded into almost any shape desired.

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BOUNCELESS BALL

Points Way Toward Improved Electrical Units

MORE positive operations of electrical relays—delicate, swift-acting switching devices which are used in communications systems—is now being assured as the result of experiments with bounceless balls. Engineers have found that a steel ball half filled with metallic powder will not bounce, as proved by the time exposure photograph reproduced in these columns. During the exposure of this photograph, two balls of the same weight—one empty and one containing powder —were dropped simultaneously from the top of the posts. The empty ball left a looping trail of light as it bounced on the steel plate, but the ball containing the powder rolled without bouncing. Rough surfaces of the metal powder particles, engineers explain, created frictional heat as they slid over each other, dissipating the energy which the ball would have used in bouncing.

The knowledge obtained by these experiments has been applied to relays in which contacts are made in hollow form and partly filled with powder. This eliminates bouncing and chattering of contacts. In some special cases, hollow powder containers are attached to the contacts for the same purpose.

MOISTURE IN WOOD

Determined With New Electrical Instrument

SPEEDY and accurate determination of moisture content in wood, by the dependable electrical resistance method, is now possible with a simple, moderate-cost instrument which supplies direct readings in moisture-content percentage terms. With such an instrument it is possible to meet various specifications covering the precise condition of lumber, as called for by the Army, Navy, F.H.A., critical architects and builders, lumber mills and dealers, furniture manufacturers, railroads, public utilities, and others.

This simplified wood-moisture tester, developed by Industrial Instruments, Inc., is a modified Wheatstone Bridge using a cathode-ray electronic tube as the null or balance indicator. The combination switch and control knob is rotated until the null indicator flashes, at which point moisture content is read directly on the dial. Since the bridge circuit is self-compensating, there are no variables to contend with or compensate for such as voltage fluctuations or varying tube characteristics.

The standard pin-type electrode furnished with the instrument will not permanently mar the surface of the material under test. It is readily driven into and extracted from the lumber

Indicates degree of dampness

or wood by the hammer-extractor furnished. Or if progressive checks on various lumber stacks are to be made throughout the curing period, leads may be soldered to properly placed and spaced nails, and tied into a panel board located near the instrument for periodic readings.

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LACQUERS—Until the development of quick-drying lacquers it was thought that lacquer finishes had to be slow-drying in order to be durable. Long-time tests of the quick-drying types have disproved this theory.

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GUAYULE

Compounded with Synthetic and Natural Rubbers

MOUNTING demand for guayule rubber resulting from its widened use for compounding with synthetic rubbers has led to doubling the productive capacity of Cia Hulera de Parras, important producer of guayule, according to an announcement by American Cyanamid and Chemical Corporation, representative of the Mexican company. The increased capacity is being put in with the co-operation of United States government agencies.

Use of guayule, a type of rubber derived from a Mexican shrub thriving in semi-arid regions, has in the past been small because of its high content of resin, which is undesirable in rubber. Present rapid extension of its use is based on the improved properties which guayule (containing its original resin) imparts to synthetic rubbers, particularly of the Buna S type. Guayule serves not only as an additive and extender for the synthetic, but at the same time it increases the adhesiveness or "tack" of the product, an important property in working the synthetic.

Aside from the decided benefits of compounding guayule with Buna S and other synthetics, its use in increasing amounts for compounding with natural and reclaimed rubber in many applications is urged to extend the life of our dwindling stocks of natural rubber.

PATTERN PLATES

Made from New Board Which Saves Metals

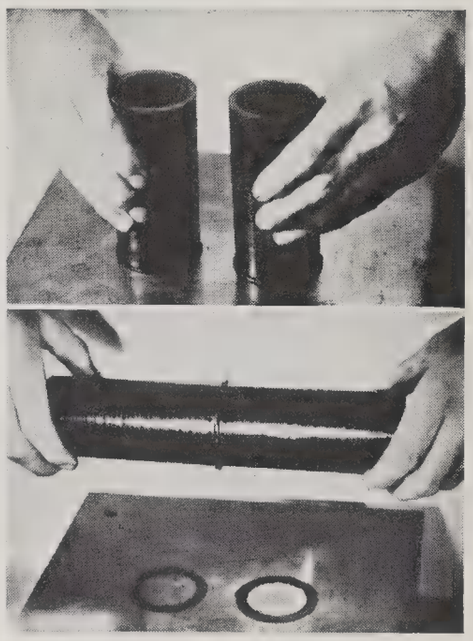
A LAMINATED plastic board which is available in a stock range of thicknesses is now being used for making pattern plates, as a substitute for aluminum or magnesium. The board, called Lignolite, does not warp, can be machined, and is impervious to moisture, oil, grease, and dilute acids. The surface of the board is designed to prevent sand from sticking to it and the stock itself has ample strength for pattern purposes.

PLASTIC PIPE

Has Many Applications to Replace Strategic Metals

A NEW plastic pipe, manufactured in the same dimensions as extra strong steel pipe of two-inch outside diameter or less, has properties of resistance to extreme moisture, chemicals, and solvents, coupled with high strength and long fatigue life. It is entirely unaffected by water, and only a few solvents exhibit any adverse effects. In many applications this new plastic pipe will undoubtedly replace strategic materials, such as vital metals and rubber, and release them for more urgent needs associated with the war effort.

This new pipe, developed by The Dow Chemical Company, is made of a new thermo-plastic resin known as Saran. The base resin is odorless, tasteless, and nontoxic. The plastic does not burn and its toughness and abrasion resistance are of a high order, the retention of these properties on aging insuring excellent wearing qualities. This pipe is non-scaling and withstands freezing. Heat resistance is said to be excellent up to 175 degrees, Fahrenheit.



Hot-plate welding of plastic pipe

Saran pipe is produced in smooth, round, accurately sized lengths having dimensions identical with those of strong iron pipe. It can be readily welded, heated, and bent. The pipe can be cut with a wood or hack saw and threaded with ordinary iron pipe dies.

ETHYL CELLULOSE

Is Base of Rubber-Replacing Plastic

A NEW plastic made from cotton and alcohol, which can replace rubber in hundreds of everyday articles, has a base of ethyl cellulose, which has been in production for some time by Hercules Powder Company.

New, soft formulations of this plastic can be used instead of rubber in hospital sheeting, gun covers, tents, garden hose, mason jar rings, surgical tape, gloves, electrical tape, wire insulations, impregnated and coated fabrics, washers, water tubing, footwear, raincoats, golf balls, and baby pants. Resistant to war gases, it can be used for gas masks. Flexible even at temperatures of 70 degrees below zero, it can be used for electrical insulation in motors of high-altitude bombing planes.

The new plastic formulations, while not now suitable for tires or inner tubes, will probably be suitable for a variety of other applications which before the war annually consumed 60,000 tons of rubber.

Raw materials used in the manufacture of ethyl cellulose are cotton linters or wood pulp, common salt, and alcohol from natural gas or from fermented farm products.

Ethyl cellulose is inferior to natural rubber in "bounce" or resiliency, it will tear more readily than rubber, and it is not as elastic. On the other hand, it can be made flameproof, a quality not found in natural rubber.

The soft type plastics now available are chemically related to rigid type cellulose plastics, based on ethyl cellulose, cellulose acetate, or nitrocellulose. Chemists can make a rigid or soft plastic by varying the plasticizing agent; for ethyl rubber, chemical or oil plasticizers, such as raw castor oil or cottonseed oil, have been employed.

INDUSTRIAL TRENDS

CHEMISTRY IN THE FUTURE

EVERY so often it is needful—and stimulating—to lift the lid of the chemical industry and see what's cooking. Much of the cooking, of course, is shrouded in the steam of military secrecy, yet enough is visible to serve as an indicator of what is going on within, and, therefore, as a key to general trends.

Regular readers of Scientific American have been able to follow in our monthly issues the story of day-by-day developments within the chemical industry. Spread over a period of time these developments often lose significance, a loss which can be recovered only by bringing the whole picture into clear focus and examining for general trends those phases which, at the moment, appear to hold the greatest promise for the future.

Such focusing was so ably accomplished recently by Dr. Charles N. A. Stine, Vice-President of Du Pont and its advisor on research and development, at a meeting of the American Chemical Society, that we can do no better than to skim the highlights of his address and let the shadows fall where they may.

Emphasizing that the war is compressing into the space of months developments which might have taken half a century for realization if necessity had not forced the pace, Dr. Stine said: "These pressures are unprecedented. Give us a victorious peace and the freedom of enterprise it should grant, and our progress will be unprecedented."

Some of the progress which has already been traced and which will be reflected in the trends of the future were enumerated by the Du Pont chemist. Aluminum production, for example, will be such by the end of 1943 that enough metal will be produced in one year to build three times the number of passenger cars now operating on our American railroads.

Petroleum chemists of today see existing motors as out of date, as a result of the war pressure to create better fuels for airplanes. In the same field, it is noted that the new motor-car models that are gathering dust in dealers' storerooms have aged technically at least two decades since they were manufactured. For example, the chemists have collaborated in the development of sealed cooling systems, now used in aviation, which will undoubtedly be applied to the automobile of the future. Power per gallon of fuel will increase, and fuels will yield much greater mileage.

In the field of plastics there will be available, after the war, the most versatile of materials on a scale beyond all previous comprehension. The high-pressure synthesis of ammonia, one of the major chemical exploits of the century, will so boost the production of fertilizer chemicals as to change completely the basic trends of agriculture.

Then there are such things as unbreakable glass and glass that floats, wood that won't burn, and laminations of plastics and wood that are competing and will compete even more with structural metals. Nylon, derived from air, water, and coal, one of the wonders of pre-war days, will be but a forerunner of many innovations from the same source. These new products will range from shoes that contain no leather and window screens that contain no wire to machine bearings that contain no metal.

In still another field there is magnesium, a structural curiosity only a few years ago, which today enters into the construction of every fighting airplane that is built. After the war it is now estimated that the nation's capacity for producing this lightest of all structural metal will be more than double that of the aluminum output of 1939.

In the rubber field, the United States alone, declares Dr. Stine, is now undertaking to accomplish, synthetically, in less than two years, the manufacture of chemical rubbers to a degree which, in the natural rubber field, required more than a century of development.

Many other new things are coming from the chemists' test-tube for use in the post-war world: New fabrics for clothing, steel that will challenge the new light metals, things to be made from the chemical building blocks of hydrogen and carbon that come out of the thousands of chemical compounds in every barrel of crude oil, new homes made inexpensively of new materials and painted with new paints, developments in medicine which may eventually outweigh even the staggering losses of this World War, and so on.

Here indeed is a heartening picture of the chemical industry as a whole, painted by one of its ablest members. From such a picture can be gleaned an assuring view of the future possibilities of this esoteric industry which holds such tremendous possibilities.

WELDING AND CUTTING

ONE of the hottest flames produced by man—at a temperature of some 6300 degrees, Fahrenheit—is being applied in many ways to aid forced-draft war production of fabricated metals in many forms. This flame, furnished by the oxy-acetylene torch, can weld metals together in a joint stronger than the metals themselves, can cut many metals apart in a fraction of the time consumed by other methods and with a minimum of loss, and can be used to surface-harden or to clean metal surfaces preparatory to painting and similar operations.

These lines are not intended to detract from the value of electric-arc welding, but rather are written to clarify the oxy-acetylene situation, to point out the uses of this versatile flame, and to indicate general ways in which these uses will extend into the future.

None of the welding methods in use today is exactly new, except in refinement. These refinements, and mass methods of application, however, have meant a tremendous speeding up of many industrial processes. Welded ships probably symbolize most graphically the construction methods using welding which are speeding the war effort. Within these ships, also, are found other products of the oxy-acetylene torch—metal sheets and plates of various thicknesses cut to exact sizes to fit the spaces assigned to them. These sheets have been cut—often in duplicate—by the same gas flame that later welded them together in an unrelenting embrace. So accurate is the cutting flame, in fact, that complicated machinery has been designed to guide the flame as the operator follows a pattern; many such machines use multiple torches to speed up work, or one torch may be used to cut a series of plates stacked one on top of the other.

Then there are methods of surface-hardening metals using the oxy-acetylene flame to heat the surface, which is then quenched by one of several means. Lastly, the same flame will clean surfaces of rust, paint, scale, and so on.

We have heard much of this industrial tool during the war speed-up; we will hear more of it in the future.

—The Editors

Portentous Eclipse

The Recent Eclipse of the Moon, an Odd One, Afforded Astronomers More Fun than Usual

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

GREAT numbers of people must have watched the eclipse of the Moon on August 26th. Observing conditions, in this part of the country at least, could hardly have been better—a brilliantly clear night with the eclipse coming on in the evening and at its maximum a little before midnight (more than an hour before, were it not for "war time") so that the eclipsed Moon, despite its southern declination, was well up in the sky. The writer, who has seen a good many lunar eclipses in his time, wonders how many of the thousands of watchers realized that they were beholding something so unusual that, to the experienced eye, it seemed to be almost what the ancients called a "portent."

The early stages of the eclipse passed off as usual—the dimming of the eastern edge of the Moon by the penumbra, or half-shadow within which the Earth hides part but not all of the Sun; the "bite" out of the Moon's edge as the actual shadow—the umbra—enters upon it; and the gradual realization that this shadow is not completely dark, but that the eclipsed part of the Moon is faintly visible.

As the Moon swept deeper and deeper into the shadow, one noticed, as usual, that this illumination was fainter and redder in the inner part of the shadow-circle than near its edge. Then came the surprise—the upper right-hand edge of the Moon became much fainter than the rest. The dark area spread and, near the middle of totality, the Moon looked as the writer, at least, has never seen it before—with dark center and a light ring all around its periphery. Then the eastern edge slowly brightened, and the dark area moved toward the western side as the Moon passed away from it toward the light.

The faint reddish illumination of the eclipsed Moon is normal: but the presence of a relatively small and conspicuously darker spot within it is so unusual that the effect was uncanny.

Like all other "portents" in the heavens, it has of course a perfectly natural and fairly simple explanation—which, this time, demands only the drawing of a few diagrams.

Figure 1 represents the general circumstances of a lunar eclipse. It is very far from being drawn to scale. The Sun is about 50 times bigger and several thousand times as far off in comparison with the size of the Earth: but it illustrates the geometrical relations none the less. Since the Sun is larger than the Earth, the true shadow, or umbra, of the latter from which all direct light is excluded is a cone (shown in cross-section on the diagram) which tapers to a point P lying about four times as far away as the Moon's orbit. Outside this is the widening cone of the penumbra—shown by dashed lines—from which part, but not all, of the sunlight is cut off.

IF the Earth, like the Moon, was a naked body without atmosphere, the umbra would be entirely dark, except for the very faint light of the Sun's extended corona, and the eclipsed Moon would be invisible. Close to the edge of the umbra where, for an observer on the Moon, the inner corona and perhaps some prominences would be visible, there might be illumination enough to make a ghost of this part of Moon show up against the dark sky. But with the Moon near the center of the shadow all the brighter part of the corona would be hidden by the Earth and there would be nothing to see.

The Earth's atmosphere, however, being denser near the surface, acts like a lens and refracts the rays of light which pass through it inward from what would otherwise be the dark shadow, lighting it up feebly; and it is by this refracted light that we see the eclipsed Moon—as is illustrated in the figure. Rays that have just grazed the surface of the Earth are deflected inward by about 68′—far enough to carry them a little beyond the Moon's center, even when it is nearest, but not enough to take them to its opposite edge; which, however, will receive sunlight that has come close to the other side of the Earth, as a glance at the figure shows. To be deflected to the center of the umbra, at the Moon's surface, the sun's rays must pass within about a mile of the Earth's surface. A deflection of half this amount demands that the rays shall pass less than five miles above sea-level; rays with a minimum altitude of ten miles will be deflected by about one seventh of the angle to the center.

Now rays which pass as close to the surface as the first of these have a long path through the atmosphere. Even with the clearest air they are greatly weakened by the scattering of light out of the direct beam. This affects the short waves most, and results in the redness of the setting Sun, as well as the faintness of its direct light.

If the Earth's atmosphere was perfectly free from clouds and haze, the Moon, at the very center of the shadow, would still be faintly illuminated by light of the quality of a clear sunset. An observer on the Moon who happened to be for this moment at the central point of the umbra would see a narrow brilliant line of light, completely surrounding the huge disk of the Earth, and colored as the setting Sun looks to us in the fairest weather. As the Moon's motion carried him off-center, this ring would grow fainter on the side where the rays were most deflected, and soon disappear; but on the opposite side it would grow wider, brighter, and not so red—since the rays which formed it had traversed fewer miles of air and been less depleted, so that the total illumination in this vicinity would increase.

A TERRESTRIAL observer, viewing the Moon under these conditions, would see it feebly illuminated—faintest and reddest at the point corresponding to the geometrical center of the shadow—and gradually grow brighter and less red in regions remote from this. The graduation of this illumination would be smooth, with no dark patches in sharp contrast—and this is very much what is usually seen during a lunar eclipse.

Suppose next that, all around the Earth's edge, as seen from the Moon at the time of eclipse, the weather was bad, with clouds and haze piled to a depth of four or five miles. The light which would otherwise have been directed into the inner parts of the umbra would be blocked by these clouds. In the symmetrical, but exaggerated, situation which we are imagining, no light at all would enter the

central part of the umbra. If a screen three times as big as the Moon could be set up, just behind the Moon, to show the whole umbra at once, we would find the outer parts of it illuminated much as usual, but the inner region black and big enough, in the special case which we have assumed, to hide the Moon completely.

Actually, of course, the weather will not be clear everywhere along the 25,000-mile belt of the Earth's surface along which the sun's rays graze it at the time of mid-eclipse, nor will it be cloudy everywhere. If the clear and cloudy regions are distributed at random along the belt, our imaginary lunar observer will see the ring of light surrounding the Earth interrupted in many places and the illumination of the surface will be weakened: but this weakening will be general all over the Moon's surface, with no conspicuous bright or dark spots. But if the clouds are localized in one region extensive enough to cover a considerable area of the Earth's edge as seen from the Moon, the illumination of the side of the umbra toward this area will be cut down, while that of the rest will be normal.

We have then to ask what distribution of clouds will account for the remarkable dark patch. The best way to answer this is to draw a diagram of the actual situation at mid-eclipse, which is shown in Figure 2. The large circle represents the umbra, as it would have been projected on a screen just behind the Moon, and the smaller one the Moon itself at the middle of eclipse — 11:48 P.M., Eastern War Time. At this time the Moon was about 11′ north of the center C of the umbra. At about this time (the writer unwisely failed to keep a note of it) the dark spot in the shadow was very nearly central on the Moon's disk and of roughly the size indicated by the dotted circle. It was therefore far out of center in the umbra, and the light which failed to reach it evidently did so because it found obscuration along the region of the Earth's edge indicated by the arc AB in the figure. At this time the Moon was overhead at a point in longitude 56° West, latitude 10° South in central Brazil, and the Sun at its antipodes in the China Sea West of the Philippines; and the circle half way between them, along which the Sun's rays grazed the Earth, ran from the Black Sea across the upper end of the Baltic, near Spitzbergen, across the northern edges of Greenland and the Arctic Archipelago, down to British Columbia, and into the Pacific about half way between California and Hawaii. All along this line, from Norway far into the Pacific, the weather must have been bad, or, at least, cloudy.

When the dark spot extended farthest from the center of the umbra, it reached nearly half way to its boundary. To produce so great an obscuration, the clouds above the Canadian shore of the Arctic Ocean must have extended to a height of about four miles—which is a reasonable enough figure.

Above Antarctica, on the contrary, the air must have been very clear, for on the Moon's limb, south of the center of the umbra, the illumination was fairly strong.

Just what distribution of open patches between clouds let in light enough at the edges of the obscured region to make the dark spot so nearly circular would be hard to figure out—especially as the problem probably admits of many solutions.

But it is evident that all that the weird celestial portent meant was that the weather was bad somewhere else.

There may still be romancers who may argue that the thing had something to do with the war. If such folks are amenable to reason at all, they may be recommended to consider that the region in which the obscuring clouds occurred is about as remote from military activity as any part of our planet, except the Antarctic where conditions were quite different.

The brightness of the eclipsed Moon is one of the few astronomical phenomena which is really unpredictable. Some day, when men know far more about the weather than they do now, they may be able to predict in advance how high the clouds (if any) will be in the Arctic and Antarctic — but, considering the complexity of atmospheric circulation, this seems very remote. Meanwhile, it is of interest to note that this unpredictable phenomenon is not only observable from the Earth, but that it would easily be observable and perhaps more easily measurable from Venus or Mercury, provided that intelligent inhabitants could exist upon them.

—Princeton University Observatory, September 3, 1942.

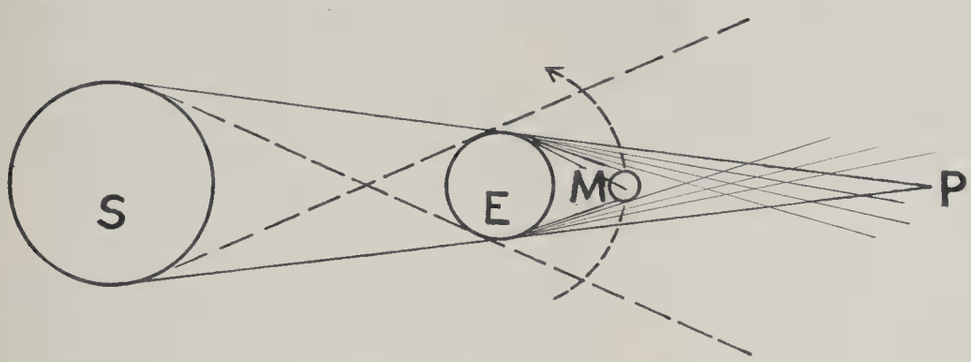


Figure 1: See the text

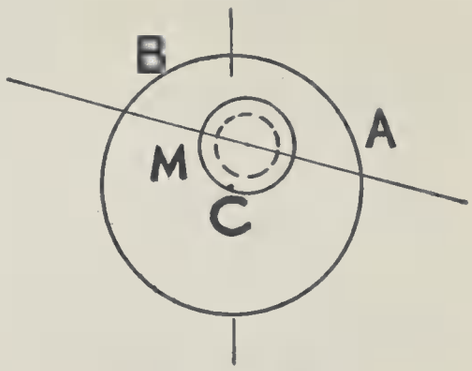


Figure 2: The situation

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Part of the eclipse, photographed at 10-minute intervals (9:50 to 10:50 P.M., E.W.T.) by Dr. Henry Paul, Norwich, New York, amateur telescope maker. A series of eclipse photographs may be made with a camera, but the results will be disappointing. Without much difficulty a small telescope—say six inches aperture—may be rigged as a special camera to do a better job. In "Amateur Telescope Making," Harold A. Lower gives instructions for this. The image at the telescope's focus will be about half an inch in diameter, but it is so bright that it may be magnified by an eyepiece to about an inch and still be bright enough to photograph with an exposure of less than one second. The eyepiece is mounted in a simple box and a ground glass is used to determine the exact best focus. A plate in a plate-holder is then substituted and an assistant is posted in front of the telescope with a black cardboard, held over its front but not touching. The slide is removed, then the card is moved away edgewise and replaced as quickly as possible. If the exposure is short enough the image will not blur due to the moon's orbital motion. A clock-driven telescope will obviate these last difficulties.

Tunneling Under Difficulties

Part of the Delaware Aqueduct Was Drilled at Great Depths, Yet Was Finished in Half the Allowed Time

R. G. SKERRETT

EXPLOSIVE gas and high-pressure water, stored in bedrock 400 feet below sea level, were the unforeseen obstacles overcome by the contractor in excavating a stretch of 75,000 linear feet of tunnel beneath a spur of the Catskill Mountains. That section of tunnel, the longest unit of the Delaware Aqueduct, will help to carry greatly needed additional water to New York City's more than seven million people.

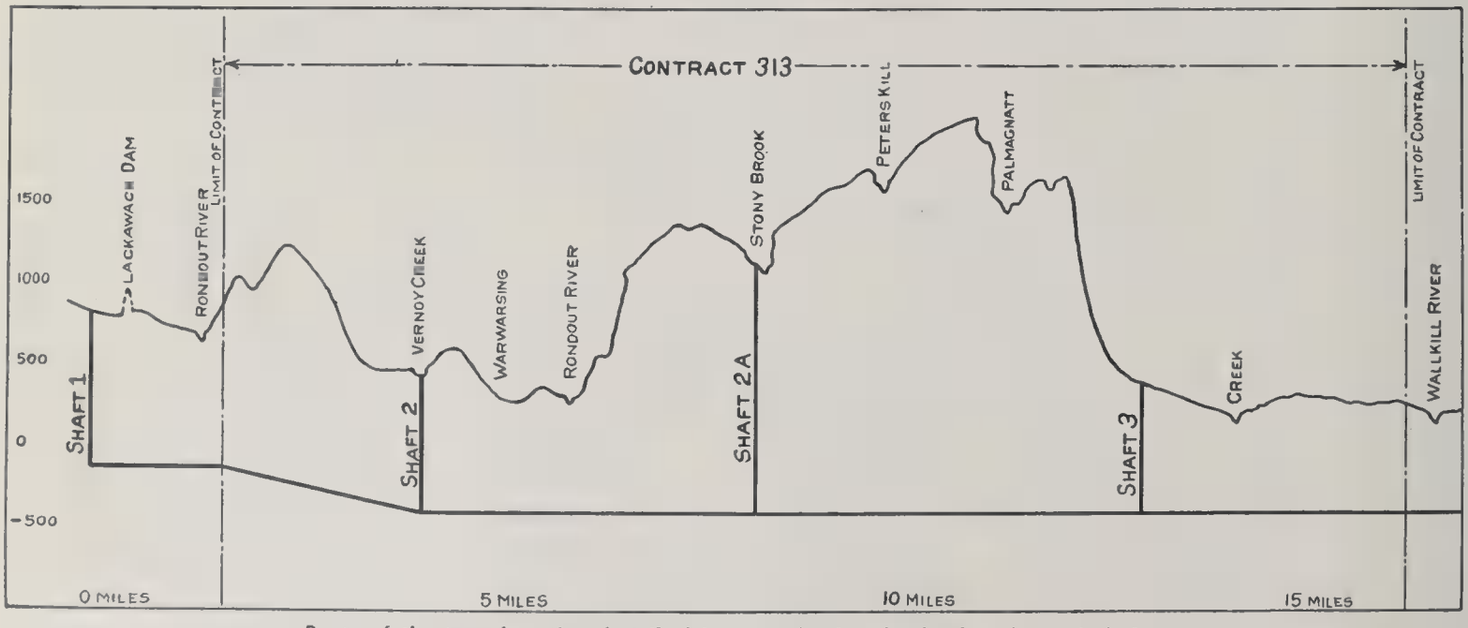
The engineers of the Board of Water Supply of that city designated that the tunnel should be driven deep in ledge rock, and that the conduit for the man-made river should have a finished diameter of 13.5 feet inside its thick concrete lining. At a depth of 400 feet below sea level, the engineers counted on finding sound rock to form the outer walls of a section of tunnel that would have to withstand a bursting pressure of 540 pounds on each square inch of internal surface. But Nature interposed difficulties.

Shawangunk Mountain, under which most of the more than 14 miles of tunnel passes, is a tremendous rocky mass that towers 2400 feet above the tunnel line and exerts an enormous downward pressure on the rock through which the bore has been excavated. When that mountain was shoved upward at some remote age, the previously horizontal layers of rock forming the earth's crust were bent, folded, and in places broken like a titanic jelly roll mishandled in the making. In time, great quantities of water and marsh gas—methane, highly explosive when mixed with ten times its volume of air—were stored in areas of the fractured and shifted rock.

STILL another hazard existed. The tunnel had to be driven through rock that was under very heavy stress, like an enormous spring under compression. When tunnel-driving offered release for those pent-up forces, the rock in the roof of the tunnel and at the heading burst inward with explosive force. To prevent the "popping rock" from injuring the workers or damaging tunnel-driving machinery, about 90 percent of the tunnel roof had to be supported by a strong protective grid of structural steel members requiring the use of 40,000,000 pounds of that metal. The roof support reached to the very rock face, where a battery of pneumatic drills drove 40 to 50 holes, into which were loaded the shattering explosive charges. Before the last of the rock was broken through in this tunnel unit, the contractor, Samuel R. Rosoff, Ltd., had used 1550 tons of dynamite in opening up the 75,000-foot section of tunnel, generally excavated from 17 to 19 feet in diameter. One stretch of that tunnel that penetrates unusually difficult ground had to be excavated to 24 feet in diameter. It was while doing this latter work that the contractor had to battle long and strenuously against grave odds to work his way forward.

PRIOR to starting the driving of the long tunnel under Shawangunk Mountain, the Board of Water Supply had another contractor sink three shafts about five miles apart, along the tunnel line. (See the drawing.) The purpose of those shafts was to provide access later for the tunnel-driving contractor so that he could tunnel in each direction from the bottom of each shaft. Thus he had six points of attack which would help to shorten the time required in tunneling the whole 75,000 linear feet. The westernmost of the three shafts, Shaft 2, was sunk to a depth of 825 feet to reach the planned tunnel line. The central shaft, Shaft 2A, was sunk from a point high up on the western slope of Shawangunk Mountain and carried down to a depth of 1551 feet. It is the deepest of all the shafts on the Delaware Aqueduct. Shaft 3, near the eastern foot of the mountain, is 840 feet deep. The shaft-sinking contractor was required to drive 200 feet of tunnel, both north and south, from the bottom of each shaft to give the succeeding contractor space in which to set up his underground machinery for promptly beginning the main operation of tunnel-driving.

While driving the 200 feet of tunnel northward from Shaft 2A, some of the rock-drill steels penetrated a cav-



Route of the tunnel section described in text, showing depths, lengths, and shafts

ity filled with compressed methane, and the released gas poured out into the tunnel heading from the rock face, mixed with the air, and in some way was ignited. The scorching blast that followed injured to varying degrees all 18 of the men at work. That was the first warning of what lay ahead for the contractor who would have to drive the long tunnel section. Experts of the United States Bureau of Mines promptly visited the scene and reported that it would be hazardous to continue underground operations unless means were provided for quickly disposing of all incoming marsh gas before it could form an explosive mixture with the free air in the tunnel. They specified that at no time should the marsh gas in the tunnel air exceed the trifling amount of 0.25 percent. Care was also to be taken that there should be no sparking of electric machinery, bare flames, or smoking.

The tunnel-driving contractor prevented the marsh gas from doing harm by employing an unusual system of tunnel ventilation. Near the top of each shaft, he placed large motor-driven blowers from which two metal vent pipes, each 28 inches in diameter, led down the shaft and thence, one each, to the opposite headings. At the rock face of each heading, a battery of pneumatic drills, mounted on a mobile drill carriage, drove holes deep into the circular wall, and into each hole a charge of dynamite was loaded. When all the holes were fired, the rock was shattered for a depth of 10 or more feet.

At the front of the drill carriage, top and bottom, were two suction intakes, each eight feet long and five inches wide—like gigantic vacuum-cleaners—that continually sucked away the air close to the rock face. The strong suction at those intakes—that picked up both dusty air and any marsh gas that might issue from the rock—was created by a powerful Roto-Clone blower mounted on the drill carriage. The blower discharged backwards through a fabric duct into the nearby open end of the big metal vent pipe, and the suction of the blowers at the top of the shaft drew the inflow speedily surfaceward and scattered it to the breeze.

The suction of the blowers caused a replacement flow of fresh air down the open passages in the shaft and then steadily onward to the headings. This stimulated circulation prevented any dangerous accumulation of any marsh gas in the tunnel sections and kept the air at all times remarkably clear and comfortable for the workers. Normally, in similar tunnel operations, ventilating blowers force air down through the vent pipes and to the headings; but such a course on the job under Shawangunk Mountain would have speedily distributed any marsh gas coming from a rock face and have increased the likelihood of a disastrous explosion.

The bulkhead that closed the heading of the tunnel against rapidly inflowing water. Lower left, at "A", is the first flanking drift that had to be abandoned. "B" indicates the seven-foot "barrel drift" which was eventually lined with 18 inches of concrete

THE exhaust or suction method of ventilation made it possible to use Diesel locomotives, which previously were not permitted underground. The locomotives on this tunnel section have pulled heavy train loads of concrete for the tunnel lining at high speeds, thus hastening the work and shortening the time before more mountain water can be transmitted to New York City.

The resourcefulness of the engineers on this job was put to the greatest test in their battle with high-pressure water while driving the heading southward from Shaft 2. The gangs, working in three shifts of eight hours each, drilled, blasted, and removed the broken rock without cessation during each 24 hours. This work went on steadily for nearly seven months, during which the heading advanced a total distance of 6778 feet. Then scouting or exploratory drill holes, driven deep in the rock beyond the face, tapped water that flowed into the tunnel at an hourly rate of 24,000 gallons. Prepared for such a contingency, the men promptly moved special pumps up to the "firing line" and forced a mixture of cement and water—grout—into the hidden water-bearing limestone to arrest the inflow. It took 6000 bags of cement to bring the water under control. Tunnel driving was resumed and went ahead 175 feet, when another scouting drill hole again struck water that discharged forcibly into the tunnel. Once more grouting was used with some success; but shortly thereafter other exploratory holes increased the incoming water to 400 gallons a minute. Tunnel-driving was then halted lest a source of water be tapped that might inundate the entire tunnel section. The battle line had to be reformed and strengthened to avoid sudden disaster.

The entire rock face of the heading was covered and sealed with a reinforced-concrete wall or bulkhead 10 feet thick; and, when water still came through the lower part of that barrier and the rocky floor of the tunnel at that point, the bulkhead was fortified with a supplementing wall of reinforced concrete 18 feet thick, reaching from the floor up to nearly half the height of the bulkhead. Through the total thickness of 28 feet of the combined barrier, four-inch steel pipes, embedded in the concrete, were used to guide drill steels in making the next exploratory drill holes; at the tunnel side each pipe was fitted with a valve that could be closed to shut off water that might issue from the rock when penetrated. The same pipes, with the valves open, could be used to

Inside the "barrel drift" with water coming in through still-open pipes. Through these same pipes drills were run and a special grout mixture forced under high pressure

force grout into the rock ahead at pressures as high as 1000 to 2000 pounds per square inch.

Gages attached to some of the drain pipes registered a water pressure of 290 pounds per square inch, indicating that the water entering the tunnel was in some way connected with Rondout Creek, the surface of which lay 650 feet above the tunnel itself. The creek water had worked its way through the ancient bed of Rondout Creek, 400 feet thick vertically and formed of sand, gravel, and boulders deposited when glaciers had covered the countryside. This water had continued downward through fractured and fissured ledge rock that had a thickness of not less than 260 feet and that lay squarely across the line of advance for the tunnel. Here was difficult and dangerous ground that had to be penetrated with a minimum of lost time if the tunnel were to be completed. The methods that were used proved to be highly successful, although the first attempts at conquering the bad ground met with complete failure. But once more the engineers were resourceful and attacked the problem from another angle.

When grout, forced through drill holes to a distance of 70 feet ahead of the bulkhead, did not seal the water-bearing rock, a flank movement to sidestep the bad ground was made by driving a small tunnel or drift, eight feet square in cross-section, through the lower left-hand face of the bulkhead, to be used to try to consolidate the outlying water-bearing rock by grouting from that passage. When the inflow of water attained 2100 gallons a minute, after the drift was driven for a length of 87 feet, that excavation was abandoned and filled from end to end with concrete.

Before the drift was started, the engineers had erected a second line of defense in the form of a second concrete bulkhead 73 feet back from the bulkhead at the rock face. At the floor level and in the center of this bulkhead there was left a rectangular opening for carrying on operations, and that opening was fitted with a swinging door of massive steel that had an upper and a lower panel. It could be closed quickly, if needed, to prevent any sudden inrush of water sweeping back into the remainder of the tunnel. Large pipes, piercing the lower part of this bulkhead and fitted with valves, were to release water held between the two bulkheads and allow it to accumulate in a sump on the tunnel side of the barrier, where a group of pumps would pick up the water and send it onward to the bottom of Shaft 2. There another group of pumps, with a capacity of 9550 gallons a minute, raised the water up the shaft to ground level.

THE final means adopted by the contractor's experts to get through the bad ground and to plug the water-bearing rock was a small tunnel—a so-called "barrel drift"—circular in section and seven feet in diameter inside its 18-inch lining of concrete. That tunnel had its center just below the axis of the heading. It was advanced in five stages, of different lengths, for a total distance of 226 feet, and the forward end temporarily closed with a concrete bulkhead six feet thick. One hundred days were required to make that progress.

As the "barrel-drift" went forward, grout was forced into enveloping rock, at each of the stages. This was done through radiating holes, arranged like the spokes of a wheel, drilled through pipes embedded in the concrete lining and arranged in a ring-like formation every four feet of the length of the small tunnel. Each ring had 14 pipes that could be closed with valves at their inner ends. The drill steels, because of the confined space in the drift, were progressively lengthened in jointed sections like some fishing rods, and their full length was great enough to penetrate 10 feet of the rock outside the final excavated diameter of 24 feet of this particular tunnel section.

Grout of a special cement mixture was forced through the pipes and the drill holes of the "barrel drift" and into the water-bearing rock at a pressure of 2000 pounds per square inch, after each drill hole had been flushed with water at the same pressure to clear the way for the sealing mixture. When the heading of the drift reached sound rock beyond the water-bearing zone, the bulkhead in the "barrel drift" was demolished and drilling of the enlarged tunnel face was carried forward in the normal manner. Later, the main bulkhead, the "barrel drift," and the massive emergency bulkhead were cleared away, and the 24-foot tunnel section was excavated for 750 feet. That was done so that the ultimate diameter of 13.5 feet of the aqueduct could be successively lined with concrete, and reinforced outwardly with supplementing walls of steel plating and other steel and concrete.

BUT for the successful use of the "barrel drift" and the method used in sealing the bad ground which carried water at high pressure, the year of delay in advancing the heading south from Shaft 2 might have been a much longer one. The chief engineer for the contractor has stated that without using the means employed to shut out the water, the leakage might have reached the staggering total of 50,000 gallons a minute! The contractor was allowed four years in which to make the tunnel excavation, and yet, in spite of all the trouble encountered in battling with marsh gas and high-pressure water, the 75,000-foot tunnel section was holed through in a trifle more than two years.

OUR *Point* OF VIEW

PLANNING FOR PEACE IS PROGRESS

MUCH as normal man dislikes war, much as he yearns for peace and for the benefits that derive from peaceful pursuits, much as he protests against the wastefulness of war, he must grudgingly admit that many of the developments which are making war more and more horrible will ultimately make the peace more and more desirable. This, bear in mind, is no brief for war. Rather, indeed, it is an acceptance of the present war as a job to be done with at least a thought for the future.

In our issue of October was presented the first part of a two-instalment article surveying the effects of present operations in industry as they will be reflected in the peaceful world of day after tomorrow. Part two will be found on page 203 of this number. The thoughts presented in these two articles are, we feel, as completely divorced from wishful thinking as is possible under the stress of wartime production. They reflect vividly the determination of American industry as a whole to learn its lessons, no matter how distasteful these lessons may be, and to emerge from the present conflict with a completely new set of data on which to base a better world.

There can be no question but that the end of the war will find great changes in all industrial endeavors, that these changes will involve far-reaching dislocations on every industrial front, that these changes will in many cases be disastrous. Just how disastrous, of course, will depend largely upon how industry accepts its own responsibilities, how it plans today for the future.

It was with this last-mentioned thought in mind that the above described industrial survey was made. Every industry, large and small, simple and complicated, must realize now that not only its own future, but the future of the world as a whole depends upon this kind of planning. Such a realization will behoove every responsible man in industry to subject himself and his work to a critical analysis.

How is *your* industry planning now for the days of peace? How will *your* industry stand in the world of tomorrow when a new concept of living is rising from the knowledge gained through the war effort? What can *you* do now to aid in insuring industrial prosperity with a minimum of dislocations after the war?

A searching self-analysis on this basis can be stimulating and truly helpful. Others are doing it, as our survey results show. Everyone in industry should do it for the greatest good to the greatest number.—*A.P.P.*

IN APPRECIATION OF DOCTORS

YOU have worked too incessantly for too many years and are tired out, and you finally have to go to a doctor. He tells you what you probably pretty well knew already—that you must slow down or go down.

Let's assume that you follow this doctor's advice—but do doctors follow their own advice? Not too often. They keep on working till they drop. Is the tradition that doctors die too young from overwork true, or only a manner of speaking?

A Brooklyn doctor has found an interesting way to get the answer, which is: the more successful the doctor, the sooner he dies. Each week in *The Journal of the American Medical Association* there is a long series of obituary notices of deceased doctors. Each notice lists the dead doctor's life attainments. Naturally, some of these notices are long, some of medium length, others short, and it happens that, for reasons of appearance, the printer arranges the notices in order of length—longer ones preceding shorter ones. It occurred to the Brooklyn doctor that this weekly list, thus arranged, might provide an opportunity to determine "what price success" in medicine. So he analyzed 30 such weekly lists and found that the average age of death of the first ten doctors on them was 64.6 years, while the last ten doctors—they who had served faithfully but not gained prominence—lived on to 69.3 years. Thus the price of success proves to be about five years of a doctor's life.

The chances are that, if you are "successful" enough in your own vocation to be tired out from incessant work and forced to hunt up a doctor to tell you to ease up and go fishing, you will also be in a position to hunt up one of the more "successful" doctors. He, of course, will simply fortify your existing suspicions with enough added resolve to make them stick, and you then will take the needed rest, while he will go on working—and dying.

Now he's a doctor and he ought to know better and he does. But he also is human, and it's human to give advice that we don't ourselve take—most of us are a little that way.

But that's not the main reason for the tired doctor's keeping on and on. He doesn't find it simple to cut suddenly loose from his practice. Too many people have come to depend on him, or think they do. He can't simply fold up and walk out—or, if he can technically, he doesn't feel he can morally. All through his working life he has had to become accustomed to the fact—and it is a fact—that a doctor *doesn't really own himself;* he's a kind of public institution, or public utility. So in his subconscious if not in his conscious mind he knows he's digging his own grave. yet he's a kind of soldier—he's in it and will go through with it.

And for all of this, much of which it is feared the rest of us take for granted—if we even stop to think of it at all—the doctor richly deserves our appreciation. Five years is a high price.—*A.G.I.*

THE STRANGE CASE OF SYNTHETIC RUBBER

INTERESTING is the report of the Baruch committee on the rubber situation. Especially so is that part which criticizes governmental agencies for the handling of the rubber program and which refers to errors "growing out of procrastinations, indecisions, conflict of authority, clashes of personalities, lack of understanding, delays, and original non-use of known alcohol processes." Strange indeed is any failure to take advantage of knowledge that is already part of the record.

Science can point the way toward new processes and industry can put them into use, yet all efforts can be in vain in a national emergency if those in high governmental positions refuse to recognize their duties.—*O.D.M.*

Miracle Beans

Long called "The Cow of China," the Soybean is Now Invading Almost Every Field of Endeavor

AMERICA in general has just begun to "discover" the widely varied possibilities of the soybean. Henry Ford makes steering wheels of it, midwestern farmers look on it as a promising money crop, diet and health practitioners are starry-eyed about its protein, calcium, and iron content, but these things are only a start. Dig deeper into the subject and you'll find that the little bean is a capital meat substitute; that coffee, cheese, candy, salad oil, lubricating oil, printer's ink and celluloid and glue, airplane bodies and rubber substitutes, are made from it. It's good for cattle—good for dog food and linoleum and paint and rayon panties, good for explosives, good for building bone and muscle in fighting men. It's a fine forage crop, and, like alfalfa, it will enrich the soil.

But five years from now, when the present war has made the soybean as familiar an institution in American life as cellophane and synthetic rubber, it will be well to remember that the "discovery" of today was known to the Chinese thousands of years before the birth of Christ. The emperor Shen Nung speaks of it in his "Materia Medica," written in 2838 B.C. Whole ages before this—before man had learned to scribble on stone walls or papyrus — a legend was current which has been handed down in northern China and Manchuria to the present day, telling how man first became acquainted with the soybean.

A caravan of merchants, says the legend, was homeward-bound, loaded with gold after a successful trading expedition, when it was attacked by bandits. Taking shelter in an easily defended ravine, the traders held off the attackers for several days until their food ran low. Starvation threatened—until one of the servants returned to camp with a sack of beans he had found on a vine-like plant which the animals were eating. They mashed up these beans to a paste with a little water and baked them—and on this crude biscuit the famished men regained enough strength to hold off the attackers until help arrived.

The Chinese have looked on the soybean as their staff of life for ages. Many of them have never tasted any milk but that of the soybean, which costs a quarter as much as cow's milk but contains food values that are amazing. Long has it been called the Cow of China. The Orient uses the bean not so much as a vegetable as for making cheese, sauce, bread, and meat substitutes. For thousands of years it has been the basic protein food in Manchuria, China, Korea, Japan, and the Malay Peninsula.

Soybeans on the Ford Farms

Courtesy "Ethyl News"

Soybeans first came to America in 1804 on a clipper ship whose Yankee master had ordered several bags tossed into the hold in case his provisions ran low. Admiral Perry brought home two different varieties from Japan in 1854 — but until the Department of Agriculture began a systematic study of the soybean shortly before 1900, it was regarded merely as a botanical curiosity in this country. William J. Morse, now senior agronomist of the department, is the man who has worked for 34 years with the quiet fervor of a missionary to bring the miracle bean prominently into the agriculture of this country.

His efforts are now bearing fruit. In 1929 we grew nine million bushels. In 1939 we grew 91 million bushels. It's our fourth ranking cash grain crop; we grow as much as Manchuria. The Cow of China has become a hundred-million-dollar American industry.

Why? Because the little bean really is remarkable. It actually does all those different things you hear about. The plant itself makes excellent fodder for animals, or a wonderful soil-enriching crop, and it brings nitrogen to the soil. It gained its first real impetus in Illinois, now America's biggest soybean region, when farmers planted it to revitalize the land after the reckless forced growth of corn there during the last war. But it is the bean itself, the actual fruit of the plant, which has turned out to be the treasure chest from which today's scientists are extracting food and industrial products.

The secret of the soybean's versatility lies in its chemical composition: 40 percent of it is protein, highly digestible, and another 20 percent is fat, which can be squeezed out or chemically extracted as oil.

More than three fourths of the oil now goes into food products, with the bulk of the rest going into paint, lacquers, and soaps. What's left after the oil has been extracted makes soybean meal, almost all of which is used at the moment in feed for livestock. Out of the 5 percent that does not go into animal feed we get plastics, flour for baking, glue, fertilizer, dog food, breakfast cereals, macaroni, baby foods, reducing diets, and diabetic foods —for which soybeans are admirably suited, having a very low starch content.

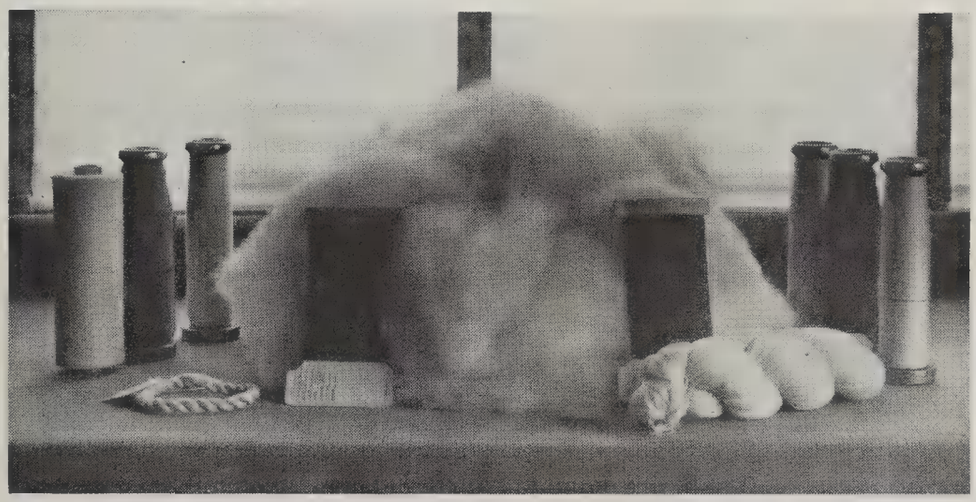
Soybean oil is now an economic rival of cottonseed oil and peanut oil in the commercial vegetable oil market. It has one great advantage here. Grown on mechanized farms with little human labor, the soybean crop can expand as rapidly as the industrial market demands. Soya oil, like many

petroleum products, is refined and hydrogenated; refining makes it sparkling clear and almost tasteless, while hydrogenation stiffens it to the consistency of cooking shortening—into which many tank carloads of it now go.

It has an overwhelming advantage as a protein food also. Usual sources of protein are meat, fish, milk, and eggs — all of which need refrigeration. But soybean meal contains a great amount of protein—and it can be shipped dry, with no cooling. This fact, plus its high nutritive value, are two reasons why the Army is using it in its new super-pemmican, Paraation. Although our national demand for soybeans in recent years has run only about 25 million pounds a year, in 1941, Lease-Lend to Britain took 40 million pounds.

One proof of the value of soybeans in a wartime economy is the importance the Germans attach to them. When Hitler and Stalin were still

Soybean fiber, being carded here, has possibilities as wool replacement



Soybean fiber, loose skeins, bobbins of yarn, on cloth made from the fiber

"friends," Germany siphoned a steady stream of beans from the Orient across the trans-Siberian railway; there were all sorts of disappointing delays, but enough beans got through to give the Germans a four-year supply. The Russians also were growing a fine crop of beans for Hitler but somehow the harvest went into Russian bins instead of railroad cars headed for the German border. This was just as well for the Allies, because the two dictators had a misunderstanding shortly afterwards and Hitler put his chemists to work on the task of making a super-explosive out of soya oil.

To show how versatile a vegetable is the soybean, look at a list of the other things Hitler could make from soya oil besides explosives. He could produce (and we're doing all this in the United States today) glycerine, printer's ink, waterproofing for umbrellas and other fabrics, leather dressing, paper coating and sizing, lubricating oil, lighting oil, enamels, varnishes, paints, soap, rubber substitutes, and lecithin. What is lecithin good for? It makes an excellent coating for chocolate confections — keeps them fresh and adds a certain nutlike flavor. It's used in the manufacture of linoleum for your kitchen floor, and rayon for eking out the country's supply of silk. And it's used a good deal as an anti-sludge stabilizer in gasoline.

Most of us recall a newspaper picture some time back of Henry Ford whanging an axe into the rear of one of his cars. He was demonstrating, dramatically, the toughness of a trunk door made of soya plastics as compared with a similar door made of standard sheet metal, in which a similar axe-blow left a gaping wound. Such pictures and stories have helped greatly toward making the public realize how much pioneer work Ford has done in finding industrial uses for the soybean and other products of the farm. In the past few months alone his laboratories have developed from soybeans water paints which stand up under a lot of abuse from the weather, and which photograph poorly from the air. They are thus excellent for camouflaging buildings, an important phase of defending our industries from attack—and have the further advantage of being easily washed off after the need for camouflage has passed, provided they are applied over the proper preparatory base. Soybean meal, made into a protein solution, can be coagulated into thread for fiber; this fiber has possibilities of replacing wool, which is now on the priorities list. It resembles wool in its general characteristics, has a natural crimp, and is about 80 percent as strong, with good possibilities that the strength will be increased. Ford fiber has been used by commercial mills to augment the supply of wool; apparently it will eventually make satisfactory felt blankets, hats, sweaters, and suits. Henry Ford has a suit made of 25 percent soybean fiber. His Highland Park mills, set up originally as a pilot plant, produced 1000 pounds of fiber a day at half the cost of sheep's wool before they were moved to Dearborn to go into increased production. Robert Boyer, his brilliant young soya reasearch chief, points out that two acres of land used as grazing pasture for sheep will produce eight to ten pounds of wool a year. Two acres planted in soybeans will produce 400 pounds of protein suitable for fiber.

Boyer's most interesting contribution, however, has not been soybean cloth or even the plastic dashboards and in-

Preparing a soybean plastic molding compound

strument knobs he casts in such bright colors. He has devised tough, lightweight, fiber-and-plastic sheets suitable for molding into automobile, jeep, or airplane bodies—tough enough to resist even an axe, as Henry Ford demonstrated for the newspaper photographers.

In these structural sheets, soybean meal furnishes the bonding resin rather than the actual fiber. (Experiments with soya fiber show that it produces very hard but very brittle sheets.) Long and short fibers of hemp, flax, and ramie are mixed and floated in water into a mat which is roughly the shape of the mold to be used. This mat is dried and impregnated with the soybean resin binder, then placed in a mold where heat and pressure shape it to the proper form —tough, polished as smooth as the mould itself, already colored without painting, and practically impervious to heat or moisture.

Since this molding process took six times as long as stamping out steel sheets for bodies, Boyer developed a method of stacking six molds simultaneously in the same press, so the output was the same. And since the plastic sheets had only half the tensile or "tearing" strength of steel, they were made doubly thick—and turned out to have collision-proof qualities ten times superior to those of steel. No jagged edges, no permanent dents. The post-war automobile body, as Ford envisions it, will be made of these plastic forms bolted in place to a tubular steel framework which will replace the conventional chassis. The body will weigh only half as much and the car as a whole will weigh only 85 percent as much as the 1942 models did.

One company is now making military airplanes with molded bodies in which soybean resin is used as the waterproof binder. Controls and ignition parts on many planes are cast of soya plastics—and the sand cores used for castings, both metal and plastic, in many defense plants are held together with a soya binder. This war has truly been an incubator for the soybean, giving it new life in a hundred new uses which would have been beyond the conception of those beseiged merchants who, in desperation, first ate the bean to stave off starvation so many centuries ago.

But let us not lose our perspective, and succumb to the popular misconception of soybeans as being primarily grown for industrial uses or for sauce in Chinese restaurants. Only 5 percent of the soybean meal produced and only 15 percent of the oil extracted go into industrial use. Soybeans are still primarily a food crop, for animals and for us. If we have to feed half another continent after this war, we could not ship any other food as nutritious, as full of minerals and vitamins, as rich in protein, as versatile in such a variety of dishes and forms, as the soybean—and this is worth noting, since we may find ourselves the Granary of Democracy after we get through being its Arsenal.

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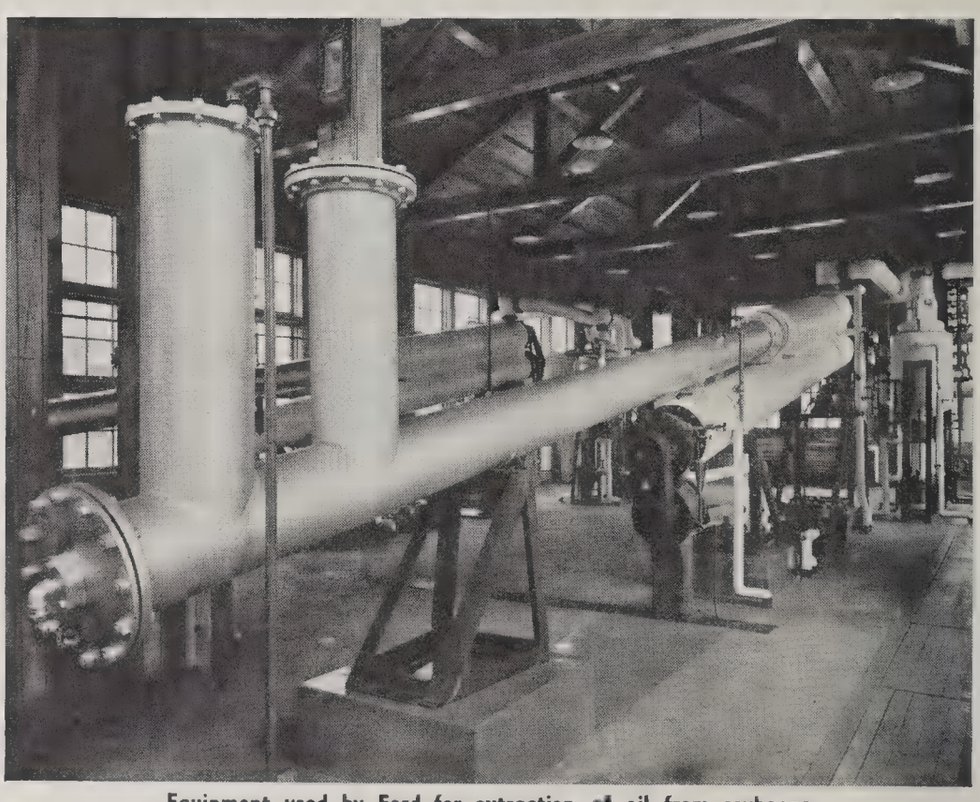
PARTIAL PREFABRICATION

Modern Phase In Building Construction has Advantages

WHEREAS the prefabricator of six years ago constructed the "packaged" house in its entirety and shipped it to buyers throughout the country, ready to be assembled on the site in a few hours, the mushrooming of the prefabrication industry in the last six months, due to necessity for immediate large-scale housing units, has introduced a new factor into house construction. This is the advent of a middleman into the prefabricating field—the partial prefabricator—who justifies his existence by supplying "parts" or sub-assemblies to the actual "prefabricating contractor" at the job.

After a trial-and-error period, a number of prefabricators found the "packaged" house construction impractical except in the immediate vicinity of the mill. Now, however, a number of companies that have gone into the partial-prefabrication field are producing portions of houses for which their plants are most fitted—wall sections, windows, doors, steps, and so on. These parts are then supplied to the actual prefabricating firm on the job



Equipment used by Ford for extraction of oil from soybeans

Next to the Stars and Stripes . . .

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Signifying 90 Percent or More Employee Participation in the Pay-Roll Savings Plan

IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly,* every pay day, through the systematic purchase of U. S. War Bonds.

You don't need to be engaged in war production activity to fly this flag. Any patriotic firm can qualify and make a vital contribution to Victory by making the Pay-Roll Savings Plan available to its employees, and by securing 90 percent or more employee participation. Then notify your State Defense Savings Staff Administrator that you have reached the goal. He will tell you how you may obtain your flag.

If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

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This Space is a Contribution to Victory by SCIENTIFIC AMERICAN

though it may be thousands of miles distant.

An example of this is the Speedwall Company, a division of I. F. Laucks, Inc., which started as prefabricators in 1936, and have built hundreds of prefabricated houses for various government and private agencies throughout the country.

The Speedwall Company is using its machinery almost entirely now for partial prefabrication. One of its principal products is giant plywood board for both exterior and interior use. A feature of the Speedwall board is that its construction is such that it is applied cross-grained to the studding. This gives a wall construction more than four times as rigid as when the plywood is applied with face grain parallel to the studding. The giant board is eight feet wide, and is run off in a continuous line like newsprint paper. Thus it can be cut to any length as required by the prefabricator.

Another partial-prefabrication is the construction of double-wall sections—containing both the interior and exterior walls of a house. The company has found that they can glue up double wall sections at the rate of 310 lineal feet of 8-foot-high partitions per hour, or 2480 lineal feet per 8-hour shift. This is enough double wall sections for 20 complete average 5-room houses per day.

The prefabricator, now that a great deal of his work has been taken over by partial-prefabricators, has become, in many cases, virtually a local distributor or assemblyman—often a general contractor, or an alert dealer. He purchases prefabricated portions of homes from various partial-prefabricators throughout the country, assembles them for occupancy on the home grounds, speeding the job and bringing all of the building industry's factors into the prefabricating picture.

PIPE FINDER

Makes it Possible to Avoid "Striking Oil"

THERE have been many sorts of divining rods for locating buried treasure, ranging from the forked hazel twig of the "water-witch" to the modern electrical detectors for locating buried cable or pipe. Perhaps the "last word" among the lot is the type developed by the Bell Telephone Laboratories, which is so accurate that it can determine within less than an inch, both laterally and in depth, the position of a telephone cable buried three feet or more underground.

This detector is also useful in locating pipes and other metal obstructions beneath the surface, as, for example, where a new cross-country cable is being plowed underground. On one 83-mile run recently in constructing a major telephone route, there were 91 crossings of oil pipe lines. By determining these locations, telephone engineers were able to avoid "striking oil" the wrong way, and also saved valuable time.

DISPENSOMETER

Aids in Accurate Fitting of Eye-Glasses

A NEW optical dispensometer molded of crystal clear "Lucite" methyl methacrylate resin combines in one instrument everything required to obtain

"Has everything" for eye-glass fitting

measurements for accurately fitting glasses to a patient's face.

The transparent plastic instrument magnifies the pupil of the eye almost three times for vertical measurements, affording greater accuracy and easier visibility to the optician.

Fitting snugly over the bridge of the nose and containing all the necessary rules and scales, it is light in weight, virtually unbreakable, and can be sterilized in any of the usual cold antiseptics.

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KEROSENE—Even in this age of progress in electricity, there are still more than 2,000,000 dwelling units along the Atlantic seaboard which use kerosene or gasoline for household lighting.

• • •

SHELTERBELT TREES

Set New Survival Record

TREES planted in the shelterbelts of the Prairie States Forestry Project last year made the highest survival record since the project, now completing its seventh year, was started. According to the United States Department of Agriculture's Forest Service, the survival shown by sample counts taken in the six prairie states was 82 percent compared to 79 percent in 1940, the highest previous record, and the low of 52 percent in 1936, the worst drouth year.

Last year's planting of 2702 miles of shelterbelts on 4696 farms brought the total to 16,104 miles on 26,375 farms. The field windbreaks, many of them more than 35 feet high, will provide the basis for protection of crops and soils on approximately 3 million acres of land or an area almost equal to the size of Connecticut. This protection, afforded where trees are already high enough, will aid in meeting food production goals.

Many of the belts planted six or seven years ago, the Forest Service reports, are already yielding fence posts and some fuel for their farm owners as a result of thinnings being made under the general supervision of foresters charged with responsibility for the project.

CONCRETE SEALING

Liquid Material Retains Water for Curing

A CLEAR liquid that is sprayed on wet concrete after finishing or on formed concrete after the form has been removed, seals the surface to retain water and thus facilitates curing. This liquid, known as Tru-Cure, does not affect the color of the concrete yet gives moisture retention of about 96 percent after 24 hours at 110 degrees, Fahrenheit, and 90 percent after seven days.

CONTAINERS

Use Cellophane to Replace Metals

A THIN transparent film of cellophane—a thousandth of an inch "thin," to be exact—is tackling the job of replacing thousands of tons of steel, tin, and rubber in the packaging of foods and other essential items for America and her allies.

One of the most important of the new cellophane applications is in the fiber "can," where it adds its protective values and strength when laminated to cardboard. Some of these "cans" resemble the familiar cylindrical ice cream container; in others the metal can body is replaced by laminated board and cellophane, with the metal ends attached in the usual way, saving 60 to 80 percent of the metal. Already hundreds of thousands of this type of package have been used to pack lard and baking powder. Ex-

periments have shown that many other products now packaged in metal containers, such as syrups and greases, powdered foods, coffee, and various oils, may also be packaged in this manner. Even concentrated fruit juices have kept fresh for months in such cardboard, cellophane-lined packages.

Another widely used form of package might be termed the bag-and-box; a leak-proof cellophane bag is formed inside a carton—or fabricated as an integral part of a carton—and tightly sealed merely by heat. Vegetable shortening and quick-frozen foods are among the foods packaged in this manner.

Curiously enough, when cellophane is added to paperboard, as in the cardboard "can" or the bag-and-box package, its use is exactly similar, both in principle and actual weight, to tin added to steel in the form of tin plate. So cellophane is replacing tin pound for pound and is enabling cardboard to replace steel many times its own weight.

Still another saving achieved by cellophane is in its conservation of metal through substitution for foil which has been used in great quantities in wrapping processed cheese. Until fairly recently the 325,000,000 pounds of processed cheese produced annually in this country used 4,600,000 pounds of foil. Air-tight, moisture-proof film does this job effectively, preventing the cheese from becoming rancid and moldy and dry.

VITAL MATERIALS

Formerly Imported, Now Produced at Home

A BRIDGE of ships spanning the Atlantic, spaced only a trifle over one mile apart, would be required to bring to America just five of the many vital war products which the chemical industry has developed synthetically since 1917.

That is the direct contribution which research laboratories and chemical developments have made in the last 25 years to alleviate the acute shipping shortage of today.

The five products are nitrates for explosives production and other uses; rubber for a mechanized army and necessary civilian transportation; dyestuffs for uniforms, various types of military equipment, and civilian clothing; fibers for parachutes, powder bags, and essential industrial uses; and camphor, used medicinally and in the manufacture of many chemical products essential to the war.

To bring these things to America in the quantities either required this year, or, where such figures are unavailable, actually imported before the chemical equivalent was in production, would require 2682 sizeable cargo ships. The distance from New York Harbor to Queenstown is 2842 miles. These ships spread over that distance from the Battery to Ireland would be just over one mile apart.

Of the products, the only one that would actually be obtainable, no matter how many ships were available, would be nitrates, with Chile the main known commercial source of natural supply. Before being made in America by the chemical industry to meet peacetime needs and now translated to vital wartime necessities, all the other products came from what are now enemy sources.

Not only is there no necessity now for protecting the 2682 ships on a voyage from Ireland to New York or its equivalent, but these ships are vessels which in all likelihood will never need to sail again. For when this war is over, the greater part of American needs for rubber may well be supplied by the man-made chemical equivalent.

A few years ago the only source of camphor was the natural product from Formosa. Du Pont now makes

THE NEW NAVY "E"-with-star—awarded first to Bausch & Lomb—is official recognition of continued accomplishment in Production for Victory. It symbolizes a singleness of purpose that justifies any sacrifice you or we may be called upon to make.

American War Birds Have Keen Eyes

FOR America's fighting forces, strictest requirements are imposed on the men who fly the fighter planes. Stamina, keen perception and split-second timing depend on condition. In the most critical physical examinations, particular emphasis is given to perfection of vision.

Several years ago, at the request of U. S. Army officials, Bausch & Lomb developed a special anti-glare glass for use in bright overcloud flying. This glass, known as Ray-Ban, has the remarkable property of filtering out excess glare-producing light, at the same time transmitting most of the light useful for seeing. Army, Navy and airline pilots—as well as target shooters and motorists—have welcomed the cool, comfortable, keen vision that Ray-Ban affords.

So, again, and in still another way, Bausch & Lomb gives aid to America's all-out for Victory. Its other contributions, more obvious, include gunfire control equipment—range finders, binoculars, aerial height finders. Behind the scenes, but of no less importance, are the instruments of industrial research and production—metallographic equipment, spectrographs, toolmakers' microscopes, contour-measuring projectors. Bausch & Lomb eyewear products—eye examination instruments, spectacle lenses and frames—keep a nation of workers at top visual efficiency.

BAUSCH & LOMB
OPTICAL COMPANY ▪ ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

EDISON STORAGE BATTERIES

Cells [illegible] in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 20 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150	Ea. [illegible]
A-6	Amp. Hrs. 225	Ea. 6.00
A-7	Amp. Hrs. 262	Ea. 7.00
A-8	Amp. Hrs. 300	Ea. 7.00
B-2(J-3)	Amp. Hrs. 37	Ea. 5.50
M-8	Amp. Hrs. 11	Ea. 2.00
L-20	Amp. Hrs. 13	Ea. 2.50
L-40	Amp. Hrs. 25	Pr. [illegible]

All cells 1.2 volts each

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less [illegible] additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on 2 dry cells..... $5.95

GLASS MERCURY TUBE SWITCHES

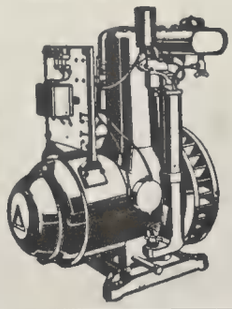
3 amp. ..... $1.25 10 amp. $2.25
6 amp. ..... 1.95 20 amp. 2.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.

Price $225.00

Additional data on request.



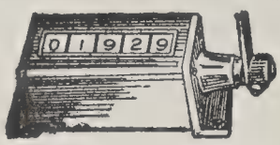
U. S. ARMY ALIDADES

Hardwood, metric scale, 0-15 cm. and reverse, and log, scale hairline sight spirit level. 45° angle adj. type, made in France $1.95

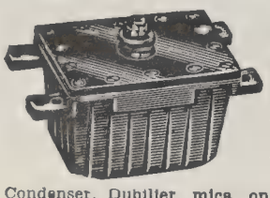
HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veeder-Root" Revolution Counter



Six number, (999999) non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50



TRANSMITTING CONDENSERS MICA

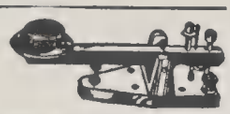
operating volts 12,500, cap. 004.
Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8,500. cap. 004 .....$7.50

NICHROME WIRE

in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95



Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound	$18.00
Edwards 10" bronze DC 5 Ohm Mech. Wound	15.00
Edwards 6" bronze DC 5 Ohm Mech. Wound	10.50
Schwarze 8" 100 Ohm 32 volt	10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

Build Your Own Searchlight

U. S. Army Parabolic Mirror Precision Quality

Dia.	Focal Length	Glass Thickness	Price
11 in.	4 in.	¼ in.	$15.
[illegible] in.	12½ in.	7/16 in.	75.
36 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few [illegible] in. slightly used metal mirrors on hand $225. ea.

U. S. Navy Divers Lantern

Electric 150 watt, any voltage, solid cast brass. 300 lb. test. Weight 12 lb.
Price $8.50

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

U. S. Army Engineers Prismatic Compass

Pocket type 360° Limited quantity. $10.50

HUTCHINSON PRISMATIC COMPASS

3 in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.

24-750 volt. Gen. Electric 200 mills	$27.50
24-1000 Gen. Elec. 1000 mills	[illegible]
12-350 volt 80 mills	$18.00
12-750 volt 200 mills	30.00
32-350 volt 80 mills	9.00
32-300 volt 60 mills	7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ¾ inch wide $2.00

Bunnell Resistance Box 1 to 10,000 ohms. A beautiful piece of laboratory or test apparatus. Complete with plugs. $30.00

New .6 H.P. 2-phase 60 cy. 220 v. 3450 r.p.m. Westinghouse. $25.00

New 1¼ H.P. 1-phase 60 cy. 110 or 220 v. 3450 r.p.m. Diehl. Ball Bearing. $55.00

Motor generator, R & M 110 D. C. 3½ H.P., 2 kw. 20 volt 80 amp. $120.00

MOTOR GENERATORS

120 d.c., 110 or 220 a.c., 500 cycles, 250 watt. $125.00 to $175.00
120 d.c., 110 or 220 a.c., 500 cycle, 500 watt. $175.00 to $250.00
120 d.c., 110 or 220 a.c., 500 cycle, 1 kw. $275.00 to $325.00
120 d.c., 110 or 220 a.c., 500 cycle, 2 kw. $300.00 to $425.00
120 d.c., 110 or 220 a.c., 500 cycle, 5 kw. $425.00 to $550.00
120 d.c. to 400 d.c. 2 kw. .... $225.00 to $275.00
120 d.c. to 600 d.c. [illegible] kw. .... $250.00 to $325.00

CONVERTERS

"Wappler X-Ray Co." 110 or 220 d.c. input—75 or 150 a.c. output.

½ KVA	$45.00	3 KVA	$95.00
1 KVA	$65.00	5 KVA	$110.00
1½ KVA	$75.00		

Radio Transmitting Key, large Navy 5 K.W., back connected, splendid action, ⅝" heavy silver contacts. $10.50

U. S. Navy rotary spark gap, enclosed multiple electrode, high speed, can handle 10 kilowatt. ¼ H.P., 110 v. vertical motor (specify AC or DC). $75.00

Telegraph and buzzer portable sets, mahogany case, 2 tone 4 contact platinum point high frequency buzzer, 2 telephone toggle switches, potentiometer, sending key, 3 mfd. condensers, transformer and 2 choke coils, receiver. ...$10.00

Webster ¾" spark coil, 110 volt, 60 cycle 30 watts, with vibrator $5.00

Motors, Synchronous, 220 v. 60 cycles 1800 R.P.M. ⅛H.P. $30.00

Motors, Synchronous, 220 v. 60 cycles 1800 R.P.M. ½H.P. $60.00

U. S. N. double current generator, 450 volt at 250 mills and 9 volts at 3.75 amp. Complete with filter. May be used [illegible] dynamotor .. $55.00

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

all the camphor it is called upon to provide from Southern pine and at a fraction of the cost.

Importations of crude rubber in 1940 amounted to 814,604 long tons, according to figures of the United States Department of Commerce. It would take 270 medium sized ships to carry a cargo of that amount from the East Indies to the United States. Because of the great distance this is the equivalent in ton-miles of at least twice as many ships, or 540, making the run from Europe to the United States.

To bring from Chile the nitrogen needed to sustain the rate of explosive and fertilizer production, and other necessary chemical uses, during the second half of the calendar year 1942, would take 300 sizeable ships making seven round trips a year.

Since dyestuffs, silk and camphor are relatively concentrated products, comparatively little shipping space is required for them. Yet in 1940, a year of very restricted buying of silk, Department of Commerce figures show 44,857,055 pounds were imported. During 1913, the last year of unrestricted purchasing of dyestuffs from Germany, 42,840 tons of dyes were imported, chiefly from Germany. During 1917, before the development of synthetic camphor, 8,621,000 pounds were imported.

The shipping requirements for these products would be 42 ships making a 2800 mile run—equivalent to the Atlantic crossing—yet the requirements of the American industrial machine now for the equivalent of these products are larger than in the years during which the Commerce Department figures were taken.

Thus the long arm of chemical research reaches out, not only to make the American industrial war effort easier, but to relieve the most acute of all present problems—shipping—and to give the United Nations the vital materials required to win the war.

MORE BUTTER

Assured by Protecting it from Mold

More than 75,000,000 pounds of butter will be wrapped in specially impregnated parchment paper during the current year to protect it from losses due to mold, reports the Du Pont Food Research Laboratory. Great quantities of butter are expected to be saved from spoilage as a result, thus helping to conserve stocks.

Mold rarely can be recognized in butter except by an "off" taste, according to food experts. Its growth can be retarded, even in warm weather,

however, by wrapping the butter in paper treated with a mold inhibitor. The baking industry also is attacking the mold problem in baked goods by incorporating mold retardants in increasing quantities of bread, pies, and cakes.

• • •

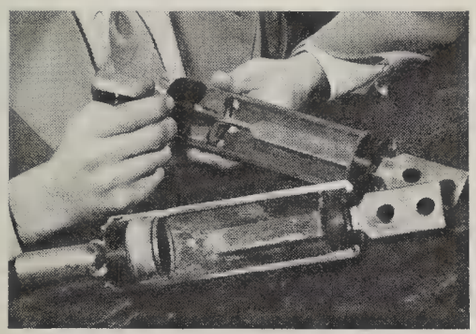
FISH PONDS—Fertilization of fish ponds results in increased growth of small plant life. This in turn makes possible a greater production of fish, in a ratio of about 500 pounds of fish per acre from a properly fertilized pond to 100 pounds for the average unfertilized pond.

• • •

CIRCUIT BREAKER

Designed to Foil Sabotage of Power Lines

DEVELOPMENT for war factory power systems of a new noise-proof "safety valve," called a limiter, that snuffs out 54,000-kilowatt torrents of electricity—equivalent to more than 70,000 horsepower—has made possible a new sabotage-proof method of distributing high-voltage power in factories.



Power-snuffer guards against sabotage

"In this new system of industrial power supply, known as a secondary network, two separate circuits supply power to all parts of the factory," said Mr. J. M. Wallace, Westinghouse engineer who developed the limiter. "If one circuit is damaged, by sabotage or a short circuit, the other circuit keeps electricity flowing to machines turning out war materials.

"The limiter was needed to protect these double-circuit cables against serious damage from a short circuit, which might be caused by worn out insulation, by water seeping into a cable, or by a wrench falling across bare conductors.

"Such a short circuit melts a pencil-sized copper bar inside the limiter, disconnecting the circuit. Otherwise, the short circuit might damage the cable more seriously and spread to adjoining cables. Once blown, the inexpensive limiter can be replaced by a new one."

The average 600-volt factory power cable is expected to carry only 460 kilowatts of electricity normally. The engineer stated that the limiter is so designed that it will not go into action as soon as this normal power is exceeded, but will wait until the short circuit power builds up to many times the normal amount.

"This delayed action is desirable, because most cables can carry an added electrical load for a short time," he said. "If the limiter waits, the trouble may clear itself, avoiding power interruption for the replacement of a blown limiter. For example, if a wrench were accidentally dropped across the power lines, it might soon melt, ending the cause of the short circuit."

But if the short circuit becomes serious, the limiter goes into action, stopping the electrical flow in a sixtieth of a second, Mr. Wallace explained. It does this by heating a narrow section in the copper bar through which the electricity is flowing to more than 4,000 degrees, Fahrenheit, transforming it into a vapor. Heat of the flowing electricity also releases a blast of gas from a piece of fibrous material surrounding the bar. The gas quickly blows out the electric arc between the melted ends of the bar, extinguishing the flow of electricity.

LIFE-SAVER SUIT

Can be Worn By Sailors on Duty

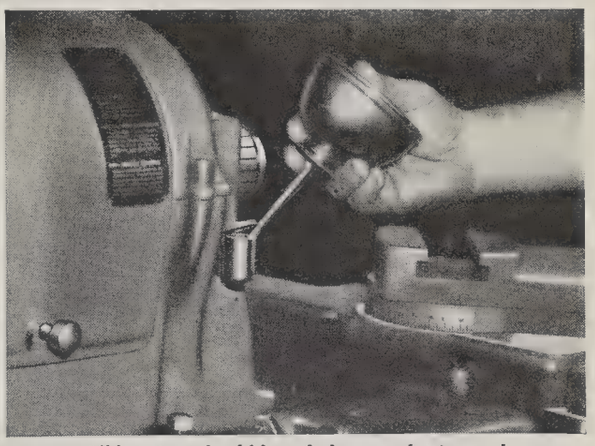
A LIFE-PRESERVER suit built to cope with today's wartime sea hazards and featuring "built-in" flashlight, knife, whistle, and yellow hood and yellow-palmed gloves is another contribution to the safety of American seamen. It has special construction affording improved protection for long exposure.

HOW TO GET THE MOST OUT OF YOUR LATHES

No. 2 in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient production.

Keep Them Well Oiled

For lack of oil the bearing was lost;
For lack of a bearing the tank was lost;
For lack of a tank the battle was lost;
All for the lack of a film of oil.



All bearings should be oiled at regular intervals

Paraphrasing the rhyme about the horseshoe nail, an army officer is said to have used this verse to emphasize the importance of lubrication.

The proper lubrication of lathes and other machine tools will help our war effort by preventing production interruptions, and saving critical materials and labor by reducing the demand for replacement bearings, parts, and machines.

South Bend Lathes, like other fine machine tools, have large oil reservoirs, felt wicks, and oil retainers to guard against lack of oil due to temporary neglect or oversight. But for best results the lathes should be oiled at regular intervals. Even a camel must have an occasional drink.

Make Oiling a Habit

All oil holes and oil cups should be filled at least once a day — oftener when top speeds and feeds are employed. Best practice is to fill each oil hole in a regular sequence so that oiling becomes a habit and no oil holes are overlooked. When the lathe is in service on two or more shifts, oiling the lathe should be the first daily task of each operator.

Use Correct Grade of Oil

When the correct grade of oil is used in a well designed bearing there is little or no metal-to-metal contact. However, when the wrong grade of oil is used, or if the oiling is neglected, the oil film will break down and the bearing surface may be damaged in a short time.

Write for Bulletin No. H2

Bulletin No. H2 giving more complete information on oiling the lathe will be supplied on request. Oiling charts for South Bend Lathes (advise serial number), and reprints of this and other advertisements in this series can also be supplied.

SOUTH BEND LATHE WORKS

Dept. 511 South Bend, Ind., U. S. A. Lathe Builders for 35 Years

1917 WAR RUN BY TELEPHONE

1942 WAR RUN BY RADIO

For Instance . . .

. . . during the grand wind up of the three-day battle of Midway —two American pilots in radio conversation.
Pilot Number One: "Do you see any gas coming out of my plane? There's no fuel on the gauge."
Pilot Number Two: "Yeah—you got a hole in your tank." . . .
(news item)

. . . a pursuit pilot who fought as a soldier on Bataan reports on a Jap landing party: "They have the best equipment I ever saw. Everybody had special field radios" . . . etc.
(news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

WITHOUT radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation.

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts." Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios. And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio. We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

—a Zenith Radio Dealer near you is giving reliable service on all radios—regardless of make.

ZENITH RADIO CORPORATION—CHICAGO

ZENITH RADIO
RADIO PRODUCTS EXCLUSIVELY
WORLD'S LEADING MANUFACTURER

The new self-buoying garment being made by the B. F. Goodrich Company weighs a few ounces over 14 pounds and slips on over a sailor's regular clothes. In an emergency, it can be donned in a few seconds.

Weighted soles keep the wearer upright without effort, so that he floats

Not a "Zoot suit," but the latest equipment for saving lives of seamen, this zipper-equipped cover-all is self-bouyant, quickly donned in case of emergency

head and shoulders above the water. A specially designed neckband prevents leaking of air or water.

Tests have shown that the suit is "manageable" enough to be worn during duty on shipboard as a shield from wind and spray. In that case, the "non-skid" material of the gloves permits handling of equipment without slippage.

• • •

WAR PROGRAM—For every hundred dollars spent in the United States War Program, $23 goes for airplanes; $21 goes for tanks, guns, and ammunition; $12 goes for transport, equipage, and miscellaneous supplies; $10 goes for naval ships; $9 goes for industrial facilities; $8 goes for posts, depots, and stations; $5 goes for merchant ships; $4 goes for stockpile and food exports; $3 goes for pay, subsistence, and travel for the armed forces; $1 goes for housing; $4 goes for miscellaneous war expenditures.

• • •

ASIA'S SECRET

How Long Has Man Been in America?

SIBERIA holds the secret as to when the first human beings came to America, how they got here and whence they came, according to Dr. Edgar B. Howard, vice-director of the University Museum, Philadelphia.

But science cannot yet give a definite answer to the query: How old is man in America. Opinion in archeological and anthropological circles revolves around the estimate of about 10,000 years ago for the advent of man on this continent, Dr. Howard explains, but extreme estimates range from about 2000 B.C. to 70,000 years or more ago.

"Many secrets, so far as our own country is concerned, are locked up in Siberia," Dr. Howard said. "Until we know more of the glacial geology, anthropology, and archeology of this region, we cannot hope to answer, with any degree of satisfaction, questions such as that relating to migration routes, the culture stage reached by these early wanderers, and many others which are necessary as a foundation to a real understanding of American prehistory." — *Science Service.*

MINIATURE MOTOR

Runs on Dry Batteries, For Specialized Applications

AN electric motor that weighs only six ounces and measures approximately one by one by two inches, has recently been designed by Delco Appliance Division of General Motors for specialized industrial and other applications in war production. These motors operate at speeds ranging from 5000 to 12,000 revolutions per minute, with outputs of from one to two watts. Operating voltages may be 6, 12, or 24 volts, supplied by dry batteries, as required.

KNIFE SHEATH

Made of Plastic, is Light in Weight

REPLACEMENT of aluminum in non-military production is one of the side-

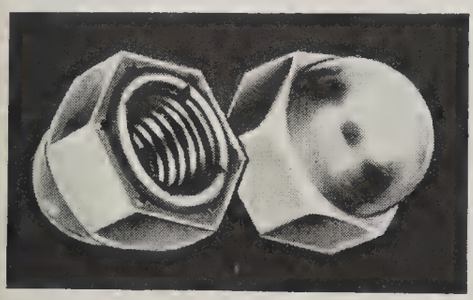
Another war-time metal replacement

line accomplishments of Plexiglas, which in itself plays an important military role in the form of transparent observation sections and turrets in bombers and fighters. One of its latest uses is in a knife sheath which fastens to the belt of packing-house workers; aluminum was previously used in order to reduce weight. The new sheath, formed from scrap pieces of aircraft plexiglas, is even lighter in weight than the aluminum, can be easily washed, has a sanitary appearance, and is extremely tough.

LOCK NUT

Locks In Bolt, Not to Work

A ONE-PIECE lock nut which anchors the nut firmly to the bolt and not to the work is shown in one of the illustrations in this column. These An-cor-lox lock nuts are provided with



Locking ring prevents "walking off"

a locking ring permanently inserted and forming an integral part of the nut. This ring is of a soft, non-springing metal which, when the nut is drawn up to the required tightness, spreads and flows inward around the bolt threads. This locking ring stays deformed even after removal and offers positive drag which prevents the nut from working off under conditions of vibration or shock.

SPEED IRON

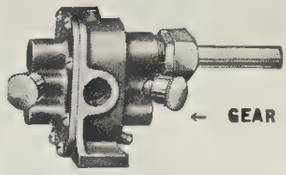
Soldering Heat Reached In Five Seconds

A NOVEL departure in the design of soldering irons is shown in one of the accompanying photographs. The heating element of this unit is a loop of No. 11 copper wire, the ends of which are held firmly in place by means of two removable plugs. Contained in the housing just above the grip of the iron is a transformer, designed to operate on any standard 110-120 volt A. C. circuit. When the trigger in the handle is pressed, current from the transformer flows through the loop of copper wire, bringing it to soldering heat in an average of five seconds. The trigger switch is so arranged that

IMMEDIATE DELIVERY

LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS

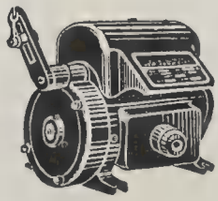


		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	¼″	⅛″	$ 6.50	$25.00
No. ¾	"	¾″	½″	13.50	32.00
No. 9	"	1¼″	1 ″	16.50	35.00

No. 1½	Gear	⅛″	Price $ 9.00	With A.C. motor	$25.00
No. 2	"	¼″	" 10.00	" " "	27.50
No. 3	"	⅜″	" 11.50	" " "	28.50
No. 4	"	½″	" 12.50	" " "	32.00
No. 7	"	¾″	" 15.00	" " "	37.50
No. 9	"	1 ″	" 16.50	" " "	49.50
No. 11	"	1¼″	" 48.50	" " "	on request

HEAT REGULATOR OUTFIT

Complete with Accessories! $21



G E H Economy Special! —The finest two-piece outfit on the market. Consists of an all electric Minneapolis Control Motor and a General Electric Thermostat. Motor is operated off your nearest light socket and has a built-in transformer supplying low voltage to the room thermostat. The thermostat is adjustable from 50° to 80°.

Easily installed on any type furnace.

Small Piston Type Air Pump

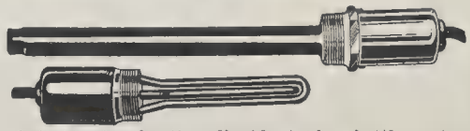
Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums. Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. **$7.95**

DURAKOOL MERCURY SWITCHES

This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	$1.10	20 Amp.	$3.15
3 Amp.	1.65	35 Amp.	5.50
5 Amp.	1.65	65 Amp.	11.00
10 Amp.	2.00	200 Amp.	50.00

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½″ iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt	$7.50	1200 Watt	$10.50
750 "	7.50	2000 "	12.50
3000 Watt	$15.00		

Synchronous Motors

New Emerson 100th H.P., 900 R.P.M. 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base. Has many applications... **$7.50**

EXHAUST FANS, BUCKET BLADES

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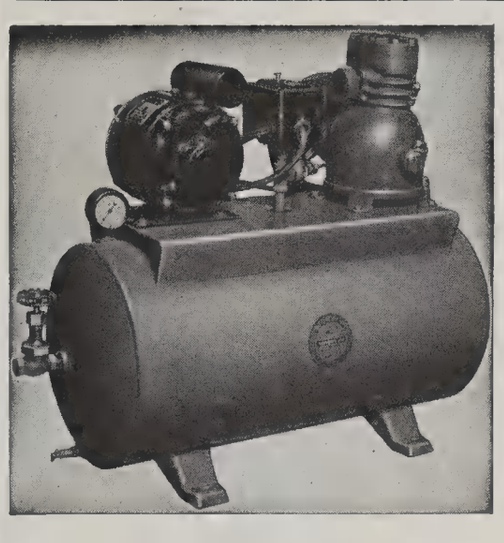
	R.P.M.	cu. ft. per min.	Price
9″	1550	550	$12.00
10″	1500	550	13.50
12″	1750	800	18.00
16″	1750	1800	21.00
16″	1140	1650	27.50
18″	1750	2500	22.50
18″	1140	2100	32.00
20″	1140	2800	36.00
24″	1140	4000	42.00
24″	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.



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FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4½″	3¾″	$22.00
0½	⅛	1750	350	6½″	3¾″	25.00
1	1/6	1750	535	6 ″	4½″	30.00
1¼	¼	1750	950	7½″	6 ″	37.50
1½	½	1750	1900	9½″	7 ″	75.00

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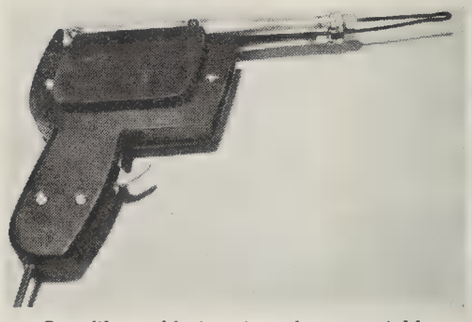
BOOKLET ON REQUEST

THE WALDORF-ASTORIA

PARK AVENUE · 49TH TO 50TH · NEW YORK

when the operator releases his grip on the iron the switch cuts off.

The manufacturer of this "Speedy Iron," Weller Brothers, states that the speed of action is such that there is virtually no waiting for the iron to attain heat. It requires an average of five seconds to pick up the iron and



Gun-like soldering iron heats quickly

place it on the work; the soldering tip is ready for operation by the time this has been accomplished. Since a standard type of wire is used for the tip, replacements are easily made.

GOLD LEAF

Production Aided by Air Conditioning

One of the most ancient arts and one of America's 20th Century industries have joined hands to facilitate the production of gold leaf, used in innumerable phases of modern life.

In order to obtain uniform gold leaf so thin that a pile of 1200 sheets is thinner than a sheet of writing paper, Hastings and Company, Philadelphia, one of America's oldest gold beating firms, utilizes Carrier air conditioning. For centuries, gold beaters, among the most skilled craftsmen in the world, were faced with the fact that variations in temperature and humidity caused the production of variable gold leaf. Goldbeater's skin for example, between which the fine sheets of gold are pounded, is exceedingly sensitive to moisture and its characteristics change if it becomes too moist or too dry.

Air conditioning equipment in the Hastings and Company plant, maintaining the temperature at 80 degrees and the relative humidity at 50 percent regardless of outside weather conditions, has made a modern contribution to this ancient art.

SOUND HELPS

Installations Made by Railroads, Ship Yards

The American railroad system, hard-pressed under war emergencies, is being helped in its job of transporting men, war material, and the necessities of civilian life by a number of new sound installations recently made by

RCA. The Illinois Central is using sound to direct operations in one of its most important classification yards, and has installed complete radio and paging facilities on its new "Panama Limited." The Michigan Central is increasing the efficiency of its Detroit terminal by the use of a complete sound installation. A comprehensive system has also been installed by the Chicago-Northwestern Railroad in its Chicago offices and yards, while the Pennsylvania is putting special sound equipment in 40 coaches.

Among other important new sound installations is a "military" mobile public address system placed at the Tank Destroyer School in Texas. This unit is mounted on a trailer which can be moved to any part of the camp where it may be needed for both instruction and entertainment. So successful has been the installation that the first unit has been enlarged and expanded in usefulness.

A southern shipyard is using sound equipment to carry the ceremonies of launchings to all parts of the yard, so that employees can know what is happening without leaving their jobs. A second southern yard is using sound for communication between shore and ships being moved about from dock to dock during fitting operations. A measurable increase in efficiency has been noted.

BELT AT AXIS

Inflated With CO_2, Has Auxiliary Mouthpiece

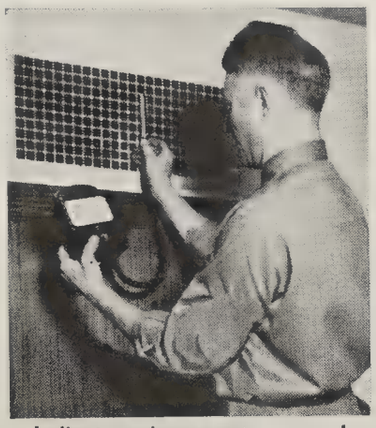
DESIGNED to cope with today's sea hazards, a two-pound self-inflating life belt is now under production at a B. F. Goodrich plant. In one of our photographs is shown a rack of these belts awaiting test in a water tank. In use, the belts are inflated by a carbon-dioxide cartridge, but a mouthpiece and tube is attached to each of two rubberized chambers to enable wearers to maintain buoyancy when necessary.

It floats, and supports the wearer

VELOMETER

For Direct Measurement of Velocity of Air Streams

AIR conditioning systems, both winter and summer, which require the use of forced air ducts, have developed a need for simple and accurate means of measuring air velocities. Thus, air conditioning engineers, architects, and others concerned with the distribution of cooling or warming air, will find many uses for the Alnor Velometer, shown in one of its forms in an accompanying photograph.



Indicates air currents on scale

In this instrument, which may be used with a variety of jets for application to different air measuring problems, there is a vane to which a pointer is attached, hair springs to control the vane, and a magnetic damping system.

It is unnecessary to include the time element in measurements with this instrument, as the pointer indications are a direct measurement of air speed.

• • •

MOTHS—One female moth and her decendants in a single year, if unmolested, can destroy as much wool as 13 sheep can produce in the same period.

• • •

WINDOW CURTAINS

Stop Light and Flying Glass Splinters

REINFORCED felted cattle hair is now being used to produce a blackout curtain which also serves as protection against flying glass. The reinforcement is in the form of wire mesh or a fabric center, and the curtain material is supplied in rolls measuring nine or twelve feet in width by 50 feet in length. Known as Ozite, this felted hair curtain is manufactured by American Hair & Felt Company.

To Get on Top in Your Job

BOOKS

READING ENGINEERING DRAWINGS
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60 pp. illus. 8½ by 11. $2.00
Airplane drawings, machine and structural drawings are covered in detail. Fundamentals common to all branches of the field are stressed. Actual manufacturers' working prints are included among the drawings.

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An old standby in modern dress. The material has been condensed and brought up to date, and now includes information on materials such as plastics and aluminum.

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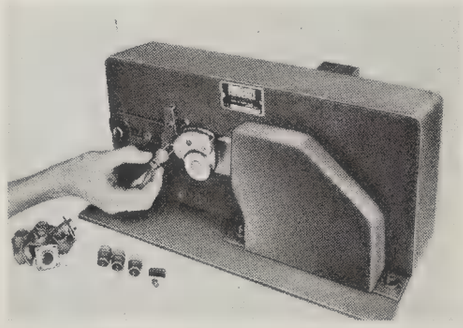


Speedy and easy to operate

machine shown in one of our illustrations. The marking may be applied to either smooth or sand-blasted finishes.

A marking speed of as high as 30 pieces per minute can be attained under ordinary conditions. In operation, the part is placed by hand on a protruding mandrel and the rotating die imprints the mark, whereupon the part is automatically ejected.

The ink used in this marking machine, manufactured by the Acromark Corporation, is a liquid dye with an acid content, dissolved in alcohol. The slight amount of acid in the dye quickly exhausts its energy after having etched the surface sufficiently to cause the dye to adhere permanently. The etching is so slight that the ink does not injure the surface nor is it dangerous to use.

It is claimed that marks made with this machine remain permanently in weather and handling tests as well as salt water, gasoline, and oil tests.

SAFETY SOLVENT

Developed to Replace Naphtha, Gasoline, Kerosene

A NEW hand-wiping safety solvent which is to be marketed as a safety replacement for naphtha, gasoline, and kerosene in removing cosmoline from rifles issued to troops, is also applicable for industrial use as a naphtha substitute for grease cleaning and hand-wiping operations in ordnance factories or shell plants. The new solvent, developed by The Curran Corporation, is marketed under its blanket trade-mark of Gunk XP-92; it is to be used as a concentrate and to be diluted with water.

This new solvent, in spite of its high solvency against mineral oil or dirt, does not de-oil the skin, has no toxic vapors, no flash or fire point, and leaves a rust preventive film so thin it cannot ordinarily be detected.

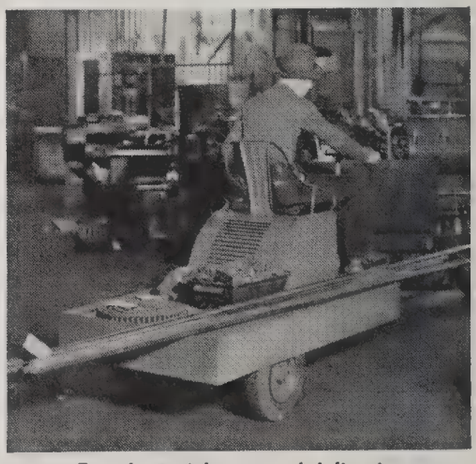
SHOP TRUCK

Motorized, Carries Loads to Half a Ton

POWERED by a single cylinder, four-cycle gasoline engine which develops over 7½ horsepower, a simple friction-drive truck is now available for industrial transportation. The body of this truck is so designed as to conveniently carry bulky material, boxes of parts, or long bars and tubes. The rear of the truck can be quickly fitted with seats so as to make the unit available for transporting officials and visitors around large plants.

The steering of this vehicle, recently announced by The Buda Company, is accomplished by one hand through an easily operated lever. The truck will turn completely around in a seven foot, three inch radius and, because of its three-wheel construction, can be maneuvered easily in narrow aisles.

Engine and gasoline tank are located under the seat, which can be quickly



For plant pick-ups and deliveries

thrown back to provide access to the entire power unit and drive. The brake is so arranged as to be controlled by a conventional pedal or to be automatically applied the instant that the operator leaves his seat.

PROTECTIVE OIL

Removes Surface Impurities,

Prevents Corrosion

OIL which is claimed to have the valuable property of completely removing perspiration, water, oil, and dirt from steel surfaces is known as Polar K, and is a development of The Curran Corporation. The new oil is said to be superior to alcohol for dehydrating and cleaning steel surfaces, bearings, or similar parts which have become wet or have been left with a film of grinding emulsion. It instantly displaces and absorbs water and leaves a thin film of lubricant and rust preventive. The Polar oil is completely soluble in hydrocarbon and lubricating oils and no subsequent cleaning procedure is necessary to remove the film.

WET GRINDER

Large Wheel For Grinding

Hard Metal Tools

A NEWLY designed 20 inch wet tool grinder incorporates in its heavy, streamlined construction improvements for grinding all hard metals, alloys, and tungsten carbide.

The standard machine illustrated features a new tool rest and wheel dresser. The tool rest is adjustable to any desired angle and has a replaceable steel wearing plate. The wheel dresser adjusts in and out from the wheel by means of a detachable hand crank which actuates a protected screw mechanism. The circulating coolant system with regulating valve located in the sludge pan to the right of the tool rest, provides quick, easy regulation of the coolant flow.

The grinding wheel furnished with this product of Hammond Machinery Builders, Inc., is 20 inches in diameter by 2½ inch face with a 9 inch hole for mounting on a large-hole wheel flange. The heavy cast wheel hood with hinged cover provides easy and quick wheel changes.

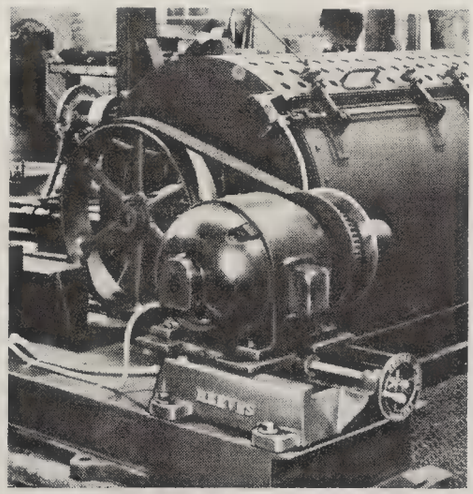
For heavy duty, high production

VARIABLE SPEED

Built Into Pulley

On Motor Shaft

INFINITELY adjustable over a three-to-one ratio of speed ranges for motors from fractional to five horsepower, a new self-contained motor pulley forms the actual drive element between the motor and the driven shaft. Thus all auxiliary equipment such as chain drives, gears, and so on are eliminated.



Not steps in speed, but any speed

This variable-speed device, manufactured by Reeves Pulley Company, consists of an assembly of two facing cone-shaped disks. One is stationary while the other slides laterally and is loaded by an adjustable compression spring. This whole assembly is mounted on any standard motor shaft. A motor base with an adjusting handwheel is also an essential part of the variable-speed drive. By means of this handwheel the motor, and hence the disk assembly, may be moved forward or backward. By means of this motion, the special V-belt used for driving is made to contact a changing arc on the disks. Thus, when the motor is nearest the driven pulley, the V-belt is at the largest arc of contact and maximum speed is obtained on the driven machine. Turning the handwheel so that the motor moves away from the driven shaft causes the V-belt to run over a smaller arc of contact and to reduce the speed.

With this pulley, belt, and motor base arrangement speed adjustability is infinite between maximum and minimum. Changes are made while the driven machine is running, and any required speed is accurately maintained as long as desired.

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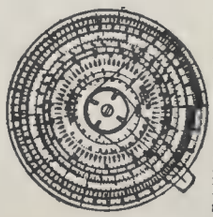

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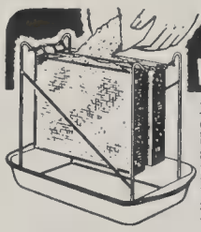

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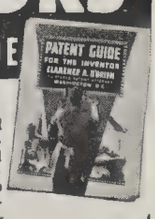

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A Troopship Of The Sky

Cargo Planes of the United States Army Are Now Carrying Troops, Jeeps, Trucks, and Military Supplies

ALEXANDER KLEMIN
Aviation Editor, Scientific American Research Professor, Daniel Guggenheim School of Aeronautics, New York University

THE Germans were the first to grasp the tremendous possibilities of the theory that greater mobility in both offensive and defensive warfare could be secured by transporting troops and weapons by airplane. Their Junkers 52, a relatively slow and plodding but roomy and reliable type of plane, has been carrying supplies, weapons, infantry, and parachutists to Norway, to Libya, to the Russian front.

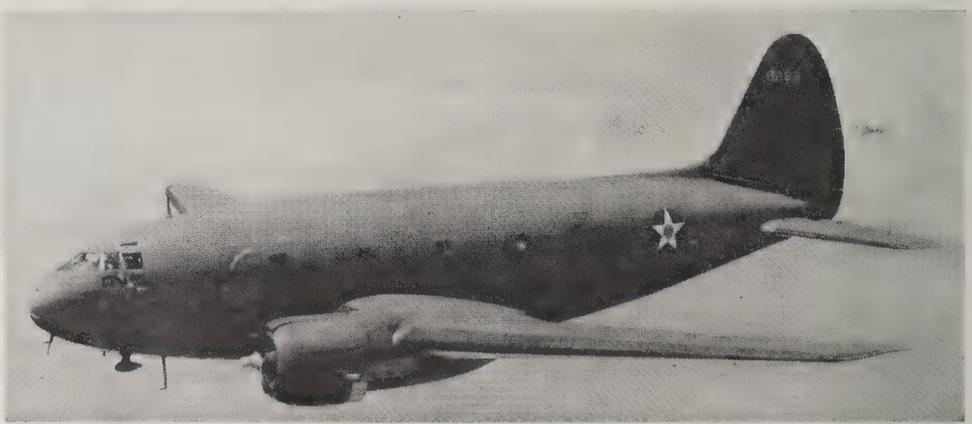
Our own Air Corps, or let us say rather our Army, was a little slow in realizing the potentialities of air troop transport. Today, however, thanks in part to the conversion of some splendid transport airplanes, we are as well equipped as any for aerial transportation; an endless stream of cargo ships is flying to China to replace the Burma road, to Northern Africa, and to other fighting fronts.

Now, for the first time, the War Department has permitted the release of pictures and information on the Curtiss Commando or C-46, a huge twin-engined airplane which originated as an airliner, and on which $2,000,000 has been lavished in five years of development and research. The Curtiss Commando has a wing span of 108 feet, a gross weight of 50,000 pounds when fully loaded, and is powered by 2000 horsepower Pratt & Whitney engines. (It is a sign of the fully cooperative spirit of the times that a Curtiss-Wright subsidiary readily accepted the installation of Pratt & Whitney engines because these were quickly available, instead of insisting on the use of Wright Aeronautical Corporation "Cyclones," which are in all respects the equivalent of the Pratt & Whitneys.)

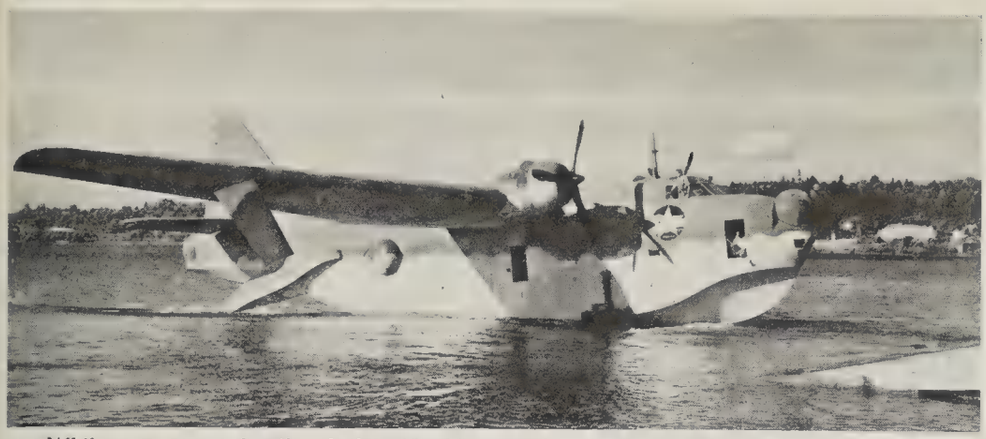
Special ramp permits rapid entry and exit of soldiers and vehicles

A huge door split in two parts and swung over head gives access to the interior of the Commando. With this door open and a specially designed ramp in position, a large group of soldiers can rush up or down the ramp at the double and enter or leave the spacious interior of the huge ship. The Commando can carry many other things than large bodies of men. Jeeps, for example can be driven up the ramp and right into the cargo compartment.

No details are given as to size or useful load of this transport, but we do know that the plane was originally planned as a 36-passenger luxury liner. Soft upholstery, roomy seats, wide aisles, and convenient lavatories



Windshield of pilot's cockpit in Curtiss Commando blends imperceptibly into streamlined fuselage. Small windows replace normal lavish window space of the airliners



While armament details of the side blister and peculiarly shaped nose of Boeing's new Sea Ranger are not available, they doubtless spell "trouble" for the Japs

have now given way to the vast interior of the cargo cabin. In one of our photographs is seen a "jeep" in the cabin, together with a number of fully equipped infantrymen occupying specially designed side seats.

The all-metal frame of the commando has been specially reinforced to accommodate heavy concentrated loads such as artillery, army tractors, trucks, aircraft engines, aviation gasoline, and other equipment and materials which may be required by a modern Army. That such reinforcement may well be necessary will be clear when we remember that in maneuver and under the action of gusts the dead weight of a two-ton truck may be multiplied into an effective, although temporary, weight of 10 tons or more.

While the Commando lands much more slowly than pursuits or bombers, as may be vitally necessary when landing in rough fields, and flies more slowly than such speed demons, it has managed to span the Atlantic in a nonstop flight of little more than nine hours.

To illustrate the cargo-carrying capacity of the Commando we are given this interesting piece of information by Burdette S. Wright, Vice-President in charge of the Airplane Division of Curtiss-Wright. "Twenty-five transports of this type would have transported all of the estimated 30,000 tons of material carried by 7700 trucks over the tortuous Burma Road during an entire month."

Commando's reinforced fuselage supports both troops and jeeps

THE SEA RANGER

From its Appearance, Bodes Ill to Japanazis

BOEING AIRCRAFT has produced a new type of naval aircraft, designated as the XPBB-I, which is intended for use as a patrol bomber, with a very long range, powerful armament, and a heavy bomb load. The Sea Ranger as shown in the photograph is to be in the same class for over water use as the Boeing Fortress for over land use. Why, then, only two engines? Because two enormously powerful engines will enable the craft to do all that four smaller engines can do, and reduce the complexity of installation. We have an analogy in the four-engined Douglas DC-4 for which the Curtiss-Wright CW-20 with its two engines furnishes a substantial equivalent. The Sea Ranger is of all-metal construction and has complete living accommodations for ten men when on an extended operational flight. The enormous size of the boat is well illustrated by comparing the size of the man with the cockpit from which he is looking out, and also by the man seated in a door of the hull proper. The nose has a curious shape and probably carries powerful guns. The windshield slopes back quite gently. We see a blister on the side of the hull which must mean more trouble for the Japs if they should ever attack the Ranger. One of the beauties of these large aircraft is that they can defend themselves against the most agile single-seater fighter. The boat has a pronounced, sharp keel line forward, which looks as razor-like as the keel line of the fastest surface vessel. The tip float mounted on a single cantilever strut seems to have the same hydrodynamic design. For the enormous powers involved, the three-bladed propeller is none too large.—A. K.

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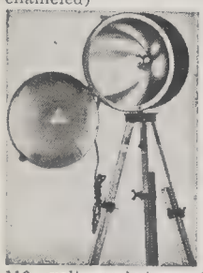

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At Service Centers

RECREATION centers for service men on leave have been set up in several places in New York City and in other parts of the country as well. Some of the visitors, whether of American, English or other nationality, make unusually fine subjects, especially when rigged out in their service costumes. Occasionally, one meets

"Eddie, of the Royal Navy"

very unusual characters, such as the 16-year-old English lad here pictured. Flash is the only practical lighting to use, in most of these cases; this one was taken with a single flash off the camera. Placing the figure against a dark flag made for a striking arrangment, and the lively expression gives the picture animation.

New Varigam Filters Cut Printing Time

A NEW type of filter for use with Defender Varigam enlarging paper has been introduced to cut the printing time without impairing contrast or other qualities. The new filters, which reduce the exposure time by half, are identified by the letter "F" following the usual designation, which now reads, for example, VG-3F. Filters nos. 9 and 10 remain unchanged, however.

Birds in Color

AN amateur ornithologist's color flash shots were recently exhibited at the Bronx Zoo, New York, where they were admired both by photographers and ornithologists—for their excellent technique by the first and their fidelity to colorings by the second. Dr. Eliot Porter, of Hubbard Woods, Illinois, who made the pictures with the aid of a Guggenheim Foundation Fellowship in Arizona and Illinois last year, achieved good results by adopting a standard technique: employing a 9 by 12cm Linhof equipped with an 18.5cm Zeiss Protar in a Compur shutter, and a Kalart Micromatic synchronizer, he shot Daylight Type Professional Kodachrome at *f*/18, with two G.E. No. 21B flash bulbs in 11-inch Victor aluminum reflectors, one on either side of the camera, with their rims 18 to 20 inches from the subject.

Incidentally, bird photographers may be interested in the standards Dr. Porter has adopted in his work:

"First, the birds must be neither out of focus nor blurred by motion; second, they must be identifiable insofar as is possible within the limitations of black and white representation; third, all other essential parts of the picture must also be in good focus and recognizable; fourth, pictorial standards of composition and execution must not be relaxed."

"Bleed" Prints

SOMETIME back someone approached us with an easel idea for making bleed prints—pictures without white borders—in which a great many criss-crossings of Scotch tape were to be employed to hold the paper in place during enlarging. The idea seemed rather impractical from several standpoints. However, we now see that someone is actually using a greatly simplified adaptation of the idea that serves the same purpose, without the necessity of purchasing a special easel. All he does is attach several strips of Scotch tape to his regular easel, sticky side up. You put the paper down and it sticks, flat overall.

Silhouette in a Gallery

SILHOUETTES have many variations. A bed sheet is a doorway with a light behind it and the subject in front is not the only way to shoot silhouettes. The accompanying one was taken from the

"Silhouette"

entrance to an art gallery, with a lady on a couch nonchalantly pulling on a cigarette as the unobserved photographer made his shot at *f*/6, 1/25 of a second. Two fluorescent lights illuminated the pictures on the wall; the lady, near the door, was almost completely in shadow. A straight print produced this result.

How Far from Subject?

WHAT is the correct distance between subject and camera for good perspective? This is a question that seems to bother a lot of people. The advice ranges anywhere from six to 12 feet. But there's a scientific rule that settles the matter not only for portraiture but for other subjects as well. Measure the distance from the part of the subject nearest the camera and the part farthest away; then multiply this distance by eight. The result is the distance at which the camera should be placed, measured from the nearest plane.

Thus, if the distance between the two limiting points of the subject is one foot, the camera should be eight feet away from the nearest plane. In the case of a head portrait, the distance might be five or six feet. If the image is too small, use a lens of longer focus, if this is available, or enlarge the wanted part of the image.

Zoo Epitome

THE simplest elements still make the most striking pictures. We don't have to see the elephant, nor the child in this picture to appreciate completely the familiar but always exciting experience recorded for us in the illustration by David B. Eisendrath, Jr., staff photographer for *PM's* Picture News. Part of a recent exhibition at the Bronx Zoo, the picture invariably brings a smile from both young and old, for who has not at one time or another offered peanuts or popcorn to the zoo elephant in return for the delightful experience of watching this favorite zoo attraction stretch forth his great, yawning snout to receive it? By concentrating his lens on essentials, Mr. Eisendrath has created a sort of symbol that fetches a universal response. The extremely shallow depth of field is due to the use of a 17-inch lens on a 4 by 5 Graflex, but note how the close view lends drama, life, and uniqueness to what might have proved just another shot of an already too familiar subject.

"Gimme"

Auto-Tire Frame

NOW that automobile tires have become so precious, why not take that spare into the house some time and use it as a photographic prop? As a frame, for example, per the illustration. A white-walled tire is best. The tire was placed on a box covered with black cloth, the lady put her head into the circle as well as she could and held the tire upright. One light at a 45-degree angle for general illumination and another very low in front to take care of the shadows, completed the lighting scheme.

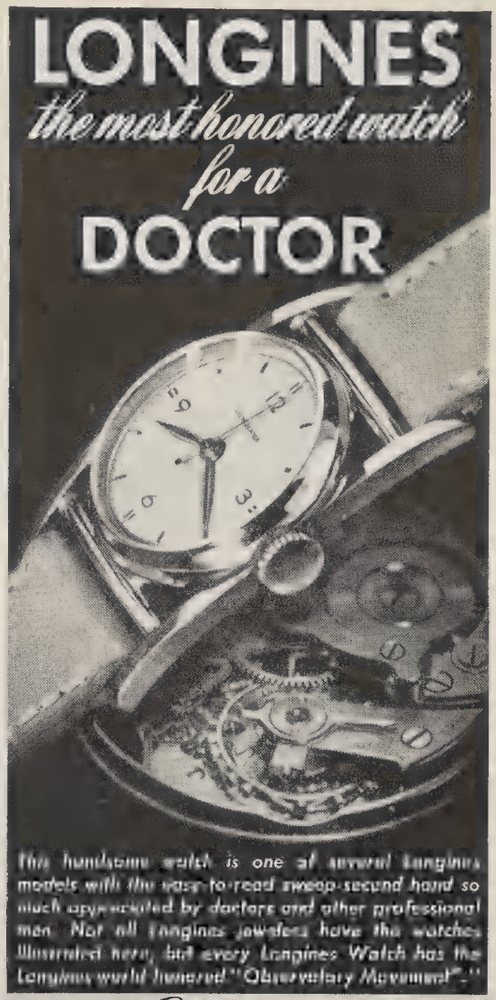
Lady and the Tire

Typing On Glossy Prints

SHOULD you have occasion to typewrite on glossy photographic paper, we understand there is a ribbon specially produced for this purpose. It is called "Clear Presidential Silk Litho No. 3, Special Ribbon," and is available from the distributors, Stanley W. Arend Company. When ordering, it is necessary to specify spooling and to give the make and model of the typewriter.

Have You Tried Proof Paper?

IN the title we do not refer to the proof paper which produces the familiar reddish-image that is here today and gone tomorrow, but to the so-called Portrait Proof Paper produced by Eastman. Single weight, developing-out type, slightly slower in printing speed than Vitava Projection, Portrait Proof is intended for making proofs by contact, with reduced illumination, or by enlargement. Supplied in matte and luster surfaces in one degree of contrast for normal negatives, this paper has such a pleasing surface and produces an image of so fine a quality that it is steadily becoming rather popular as a medium for the finished print. Particularly suitable for soft portrait results and pictorial studies, Portrait Proof lends itself beautifully to toning.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CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

PATENTS AND INVENTION is a 20-page pamphlet, in which is presented, in question and answer form, the relationship between the patent system of the United States and the war and industrial progress. *National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

LEARNING THE RADIOTELEGRAPH CODE is a 34-page booklet, plus advertising, which presents a new method of learning based on the aural system of approach. With this system it is possible for an individual to make steady progress even though the constant supervision of an expert operator is not available.—*American Radio Relay League, West Hartford, Connecticut.—25 cents.*

BIRD MIGRATION IN THE WESTERN HEMISPHERE, by Frederick C. Lincoln, contains data on bird migration and an invitation to Central and South American residents to take up bird banding as a research hobby in science. *T. Gilbert Pearson, The International Committee for Bird Preservation, 1006 Fifth Ave., New York, New York.—Gratis.*

SEEING IN THE BLACKOUT is an eight-page illustrated bulletin giving details of phosphorescent and fluorescent materials which are commercially available for use in the home and elsewhere. These materials, in sheet form, can be cut to size and nailed or cemented wherever luminous indicators are needed. *Continental Lithograph Corporation, 952 East 72nd Street, Cleveland, Ohio.—Gratis.*

ACCIDENT FACTS—1942 EDITION is a 116-page statistical yearbook which gives most of the answers to safety problems. This book was listed in this column in our October issue as being available gratis. Instead, it should have been noted that a charge of 50 cents a copy is made in quantities up to ten copies. *National Safety Council, Inc., 20 North Wacker Drive, Chicago, Illinois.*

REFERENCE GUIDE TO ULTRA HIGH FREQUENCIES is a 52-page bibliography covering 593 articles on ultra high frequency and associated subjects. *Miss E. Kelsey, Zenith Radio Corporation, 680 North Michigan Avenue, Chicago, Illinois.—Gratis.*

A PRELIMINARY LIST OF FOREIGN PERIODICALS CURRENTLY AVAILABLE ON MICROFILM is an eight-page booklet which is precisely described by its title. *Microfilms, Inc., 313 N. First Street, Ann Arbor, Michigan.—Gratis.*

CIVILIAN CONSERVATION OF THE B.T.U. is a 24-page manual dedicated to users of equipment who want the continued benefits of their air conditioning, refrigerating, and heating systems. The book serves as a handy reference guide to the simple care of existing equipment. *Carrier Corporation, Syracuse, New York.—Gratis.*

PLASTICS FROM AGRICULTURAL MATERIALS, by O. R. Sweeney and L. K. Arnold, is a 52-page bulletin which reports the results of several years of research on plastics of high impact strength and low water absorption. Four plastic products were studied, all of which showed definite commercial possibilities. *Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.—Gratis.*

BOOST PRODUCTION THROUGH INCREASED EMPLOYEE MORALE is a special report designed to help executives to make an inventory of working conditions, of management policies, and of their workers, all aimed at possible production increases and better employee morale. *Labor Relations Institute, General Motors Building, New York, New York.—Gratis.*

A GUIDE TO WARTIME CARE OF ELECTRIC MOTORS is a 24-page illustrated pamphlet which takes a fresh and up-to-date look at the over-all problem of motor care. The information given, of interest to production and maintenance men as well as to executives and others concerned with the use of electric motors, applies to all makes of standard general-purpose units. *Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.—Gratis.*

SOME FACTORS INFLUENCING THE HEAT OUTPUT OF RADIATORS is a 16-page booklet which gives comprehensive engineering data on the most important of the factors involved. Bulletin Number 29. *College of Engineering, Cornell University, Ithaca, New York.—25 cents.*

MOUNTED WHEEL MANUAL is a profusely illustrated booklet which gives detailed instructions on the operation of mounted wheels and accessories, specially designed to fit perfectly into the industrial war pattern. Content of the booklet includes a selection guide, giving detailed information on the application of mounted wheels. Another section is devoted to mounted polishing wheels. *Chicago Wheel & Manufacturing Company, 1101 West Monroe Street, Chicago, Illinois.—Gratis.*

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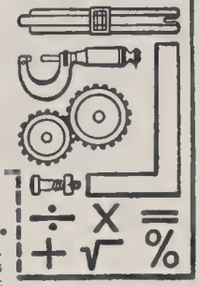

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

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Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

MOSQUITOES in summer, and cold in winter. Most amateur astronomers put up with these troubles in observing because the construction of a warmed observatory room, such as those described by Porter and others in "A.T.M.," is relatively formidable. One such type is the turret telescope and of these there are now about half a dozen. One of them, warmed electrically, has just been constructed by Roelof Weertman, of Dutch descent, member of The Amateur Astronomers Association of Pittsburgh, residing at Division Lane, Observatory Hill, Vanport, Pa., 25 miles north-west of Pittsburgh (mailing address, R.F.D. 1, Beaver, Pa.), and is shown in Figures 1, 2, 3, and 4. This is a larger, heavier, more elaborate installation than the illustrations at first suggest, the parts above the roof-line alone weighing 1500 pounds.

The telescope itself, when examined closely, proves to be more conventional in type than the first glance suggests. It is a simple, ordinary Newtonian, 12½" in aperture, an *f*/9; its 100-pound counterweight being carried on an extension of the tube rather than in separate form. This makes the tube 14' long. There are no added reflections—no siderostat as, for example, at Stellafane's turret telescope. This, of course, entails reversing the dome—toward the building as shown.

In this type of telescope the observer within the dome looks into an eyepiece which lies *in* the declination axis. He also stands within the polar axis, which is expanded into a big ring to permit his entrance into it.

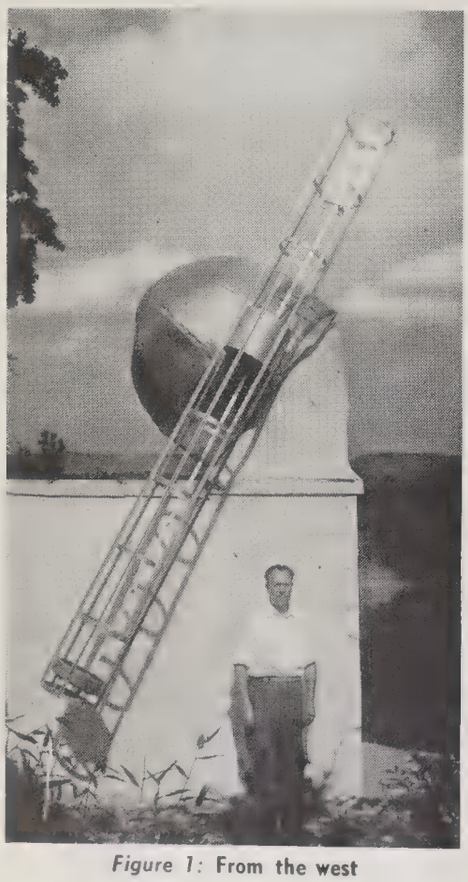


Figure 1: From the west

Starting at the bottom and working upward, as in the actual construction, we have in this telescope the following catalog of elements:

A reinforced concrete foundation on bed rock.

A hollow tile building of dimensions shown in Figure 4—narrow enough (56") to permit the tube to reach the zenith on either side.

A 2" plank floor and a 2" plank roof deck, the latter covered with tinned iron and painted.

Inside the building a stairway, as shown (Figure 4). This is only 24" wide and is on the side nearer the reader. At its head is a trap door 24" wide, and beyond this a fixed section of platform also 24" wide. The entering observer

Figure 2: From the south

pushes up the trap-door, climbs up on the fixed platform, lets the trap-door down, and thus is on a platform 33" wide and 48" long. There is ample room for two observers, but three's a crowd. Well, sometimes.

Surrounding the rectangular opening through the roof deck, where the dome emerges, a large, rectangular, horizontal, iron base, 51" by 33".

Welded to this, four upright struts of 2" pipe, to carry the tilted ring.

Fixedly welded to these four supports, a 315-pound ring of 50" inside diameter, made of 3⅝" by 4⅜" angle iron, and slanted at 49°15'. The web space between the basal rectangle and the fixed ring is filled in with metal lath and plastered inside and outside with 2" of concrete, through which there is a window (Figure 2) 14" by 27".

Bolted to the fixed ring, three 3⅛" ball-bearing rollers from automobile rear axle housings.

Pressed on one of these three rollers a 10" worm wheel to provide the friction drive to rotate the dome (done by an automobile window crank).

Figure 3: From the north

At right angles to these rollers, two 4⅜" thrust bearing rollers to prevent the movable ring and its attached telescope from slipping off.

A 215-pound movable ring of 3⅝" by 4⅜" angle iron. This carries the telescope, the dome, and the hour circle.

Welded on the movable ring a 2' length of 4" by 6" angle iron, as a base, and on this a square piece of 12" flange beam, stood on end. This unit carries the mounting for the tube, also a declination slip plate, eyepiece holder, holder for 2½" elliptical flat, declination and setting circle, declination worm, and ball bearings. A blueprint of these details may be had gratis from the owner.

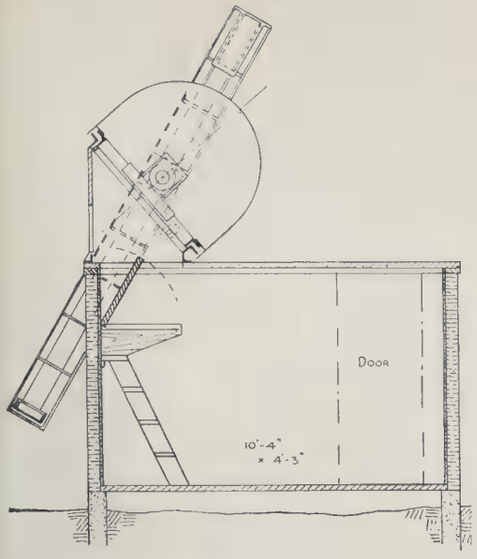
In its swing, or traverse, the eyepiece does not rise more than 1' above its lowest (E. and W.) positions.

On the above unit the tube, 14" inside diameter, built of 1" by 1" tee-bar straights and 1¼" by ¼" by ½" hoops.

At its upper end the tube carries a 100-pound counterweight.

Attached to the movable ring a dome of galvanized, riveted, sheet steel. Its interior is marked with latitude and meridian circles. Prominent stars and nebulae are indicated on it, with their R.A. and Dec., so that these and other landmarks can be found instantly.

A 12½" mirror which, before silvering, was subjected to the criticism of Norbert



Redrawn by Russell W. Porter

Figure 4: Side elevation

J. Schell, Beaver Falls, Pa., of off-axis and criss-cross off-axis telescope fame.

When the telescope is not in actual use, the mirror is left in it covered by a latched lid. A 3′ sack, like a big mail-sack (Figure 3), is drawn over the end of the tube as a protection against rain, and the tube is then turned mirror end up.

The 300-pound tube unit, including the tube's own 100-pound counterweight, is hung on one side of the movable ring. This is balanced by a 570-pound counterweight mounted inside the dome opposite the telescope.

In the photographs (Figures 1, 2, and 3) are seen respectively: Weertman; Billy Weertman, Mrs. Weertman; John Cool, Billy again, and at ground level, Mrs. Weertman again with Betty Tulip Weertman, Billy's goat (not, however, a billygoat). All—especially Mrs. Weertman—assisted in the work, even Betty. That is, when anybody made a mistake, Betty was the goat.

Weertman says the observatory once served as a fort. No sooner had he finished the concrete doorstep than a "halitosis kitty" ambled up, drove him inside, and left his or her footprints in the soft concrete.

Altogether, this is a notable telescope.

PARTIAL silvering, sometimes spoken of as half-silvering, is sometimes desired for optical instruments. Accomplishing it by the familiar Brashear process often requires agility and involves an element of uncertainty, since the silver ordinarily is deposited too quickly to permit calm, steady observation and quantitative control. Two readers of this department, Dr. Henry Paul, of the Norwich Pharmical Company, a chemist, and Dr. Wilbur Silvertooth, of Paramount Pictures, Inc., a physicist—both amateur telescope makers—have called to our attention a new method of partial silvering originally described in *Industrial and Engineering Chemistry* (May, 1942) by Robert D. Barnard, M.D., of The Chicago Medical School, as follows:

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"When the desired thickness is deposited, the plated object is taken from the bath, only the edges being handled."

Dr. Silvertooth, mentioned above, states that "We have used the method here at Paramount Pictures, Inc., with considerable success, in preparing partial transmission films."

Dr. Paul, also mentioned above, suggests caution in adding nitric acid to as concentrated a solution of silver nitrate as is used in the Barnard Method—risk of explosion (see warnings in "A.T.M.," pages 412-415). In this, Dr. Barnard concurs.

The triethanolamine needed is easily obtained through chemical supply houses.

Replying to a private communication, Dr. Barnard emphasizes again that his method was devised particularly for partial transmitting surfaces, and points out that, for full reflecting surfaces which require a heavier coating, the original triethanolamine method developed by Professor M. Meltsner, of the College of the City of New York, described in U. S. Patent No. 1,988,764, is more suitable. "Difficulties will arise in the latter case," he writes, "and the directions in the present article will have to be modified by using a much higher concentration of triethanolamine, even up to a concentration of 90 percent. Because of the difficulties encountered with the variation in composition of commercial triethanolamine solution now available, the method used in the cold, as I described it, requires a certain amount of manipulation for best results. Samples of triethanolamine containing a large amount of volatile alkyl amines (strong fishy odor) should be rejected, as should those with a large amount of chloride present. These do not appear to interfere with the Meltsner Method as much, though the last method is inapplicable to surfaces which cannot be heated."

DRIVE, clean, simple, free from gadgets and hickerpickers, made by N. J. Schell, 1019 Third Avenue, Beaver Falls, Pa., is shown in Figure 5. Asked to describe it, Schell writes:

"The drive is used with an equatorial

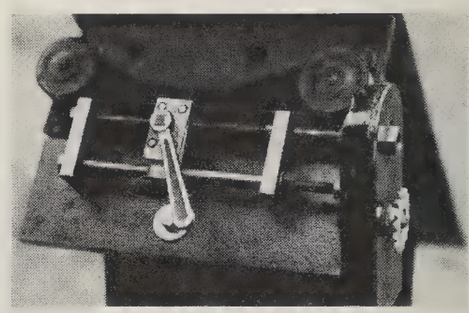

Figure 5: Schell's drive

which has for its upper polar bearing a large cast iron flange, or plate, which rolls on two ball-bearing rollers (Porter's design, I believe). I found it would be necessary to re-build the whole thing if a worm-wheel was to be used, so tried using a thin band or belt of phosphor-bronze (continuous) which passes around both rollers and under the large flange. This band is just taut when the weight is on it.

"The band is pulled by a screw of 12 threads per inch, by means of a nut which has a yoke over the top—the band passing between the top of the nut and the yoke. An eccentric pin or shaft enables the band to be clamped firmly to the nut at any point, a simple wrench turning the eccentric pin, as shown. When not clamped, the band can slide freely as the mounting is moved in right ascension.

"The drive begins with a 12-watt Telechron motor which is enclosed in a box below the main plate, continues through a train of helical gears in the narrow box at the right, terminating in the screw. The knobbed wheel on the gear box is a clutch to disengage the gears, which is necessary in order to run the nut back on the screw after it has traveled from left to right. This takes only a minute or so and, as it takes about three hours for the nut to travel the length of the screw, a single resetting will take care of an entire evening.

"The whole assembly, with the exception of the band, is in one piece and is attached by the single bolt shown just below the wrench (the pin and yoke are first slipped off, however, and the band remains on the mounting). The base of the assembly is ½" steel plate. The bar below and parallel to the screw serves the dual purpose of tie-rod and guide for the nut.

"There is no claim for originality in this design."

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

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SCIENTIFIC AMERICAN

DECEMBER - 1942

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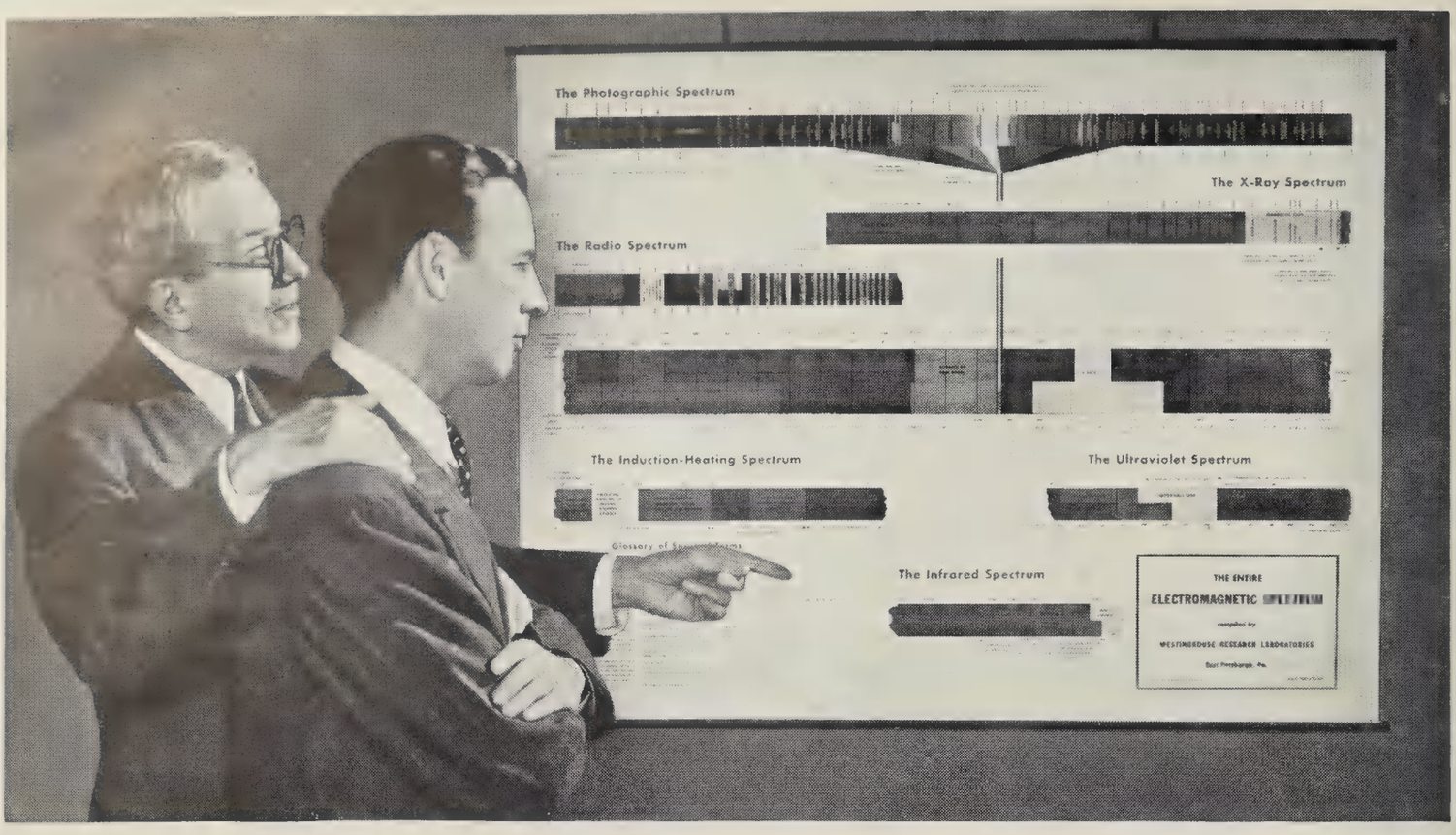
Protectors of the Merchant Marine



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WEARING new battle helmets, members of the merchant crew and Navy armed guard aboard ship practice operating a 20 millimeter gun. The crew member in the center of the picture is removing an empty magazine from the gun; the one at the right is prepared to hand over a new one. The canvas bag beneath the magazine catches the empty shells. U. S. Navy Official Photo

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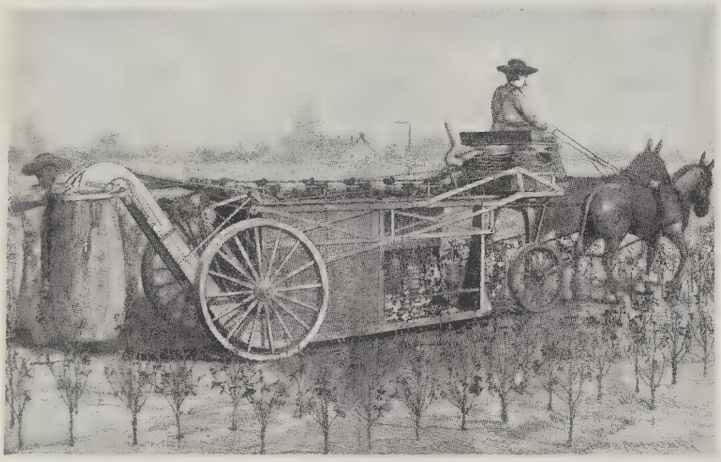
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of December, 1892)

CANAL—"At a recent New Orleans convention, which was attended by prominent business men from many sections of the country, the main effort was to bring to bear upon Congress sufficient influence to secure government aid in building the Nicaragua Canal."

STILL BAFFLING—"One of the subjects of invention which seem to have baffled inventors for many years is a practical cotton harvester. . . To a large extent, cotton planters in the South have been hampered by the difficulty in obtaining labor at the right time, and, as a result, serious losses have followed; but at length a machine has been perfected which may reduce cotton harvesting to a certainty. To run this machine, two men and a single team are required. It will harvest from 5,000 to 6,000 pounds of cotton per day at a cost of $3 to $4, as against forty men picking not over 150 pounds each per day at a cost of $30. . . The machine consists of a frame suspended on ordinary



wagon gear and inclosed in wire cloth. Within the frame are journaled two series of vertical shafts, upon which are placed beaters having spring arms. Through the bottom of the frame extends a slot, through which the stalks of the cotton plants pass. In the bottom of the frame are arranged conveyors which carry the cotton beaten from the plant rearwardly and upwardly, and deliver it to bags attached to the elevators at the rear of the machine. . . One of these machines has been in operation this season in Alabama, yielding the results we have described above."

INFUSIBLE—"Magnesia, formerly chiefly valued on account of its medicinal properties, has recently risen into great commercial importance, owing to its infusibility and its employment as a lining for converters used in the basic process of steel manufacture."

FALLING—"A fall, as a rule, injures a drunken man much less than a sober one, because, the controlling power of the mind being rendered nil through intoxication, the body falls as an inert mass, and thus the chances of injury are lessened, for, strange though it may appear, it is no less a fact that the most numerous cases of injury arising from a fall are caused by the effort, voluntary or otherwise, to avert the consequences, thus straining the muscles and tendons."

BALLOONING—"A very interesting balloon ascension took place at the end of the month of October. Mr. Mallet started at 6 o'clock in the evening of Sunday, October 23, in a balloon of 28,660 cubic feet capacity. . . . The balloon touched earth in the midst of a snow storm at half past 6 o'clock in the morning of Tuesday, October 25. The trip lasted 36 h. 30 m. No balloon has, up to the present, remained so long in the air."

YESTERYEAR—"The National Association of Carriage Builders held their 20th anniversary recently in Buffalo, New York. Among the subjects treated a particularly important one, and interesting in view of the general movement for the advance of technical education, related to the establishment of a carriage builders' technical school. . . Carriage building is rapidly developing and bids fair to become a true profession. The past year has witnessed remarkable results obtained by the introduction of ball bearings and pneumatic tires on racing wagons, and it is hard to believe that the day is not near at hand when vehicles of luxury will be thus equipped."

MATCHES—"If the worthy gentlemen who control a monopoly of the trade in matches in the United States will give ear to reason, they will improve the quality of their product, even if in so doing they have to sacrifice a tithe of their present profits. Some of the matches now sold are a nuisance because of their unreliability, while others are a constant source of danger to property, if not to life, even in the hands of careful people. A portion of these latter drop a portion of the inflammable composition invariably, and if it happens to light on combustible material, a fire is pretty sure to result."

BRITISH NAVY—"By the launch of the Revenge from the works of Messrs. Palmer's Shipbuilding and Iron Company, Jarrow, on the 3d of November, and the floating of the Royal Oak from her building dock at Messrs. Laird's establishment, Birkenhead, the fighting strength of the British navy has been materially increased. These vessels belong to a class of eight, provision for the construction of which was made in the Hamilton Defense act of 1889, and they are considered on all hands to be, as regards strength and power for battle, superior to any first-class battle ships possessed by foreign powers."

ELEVATED—"In the early days of New York elevated railways the man who appears to have most highly appreciated their value and foresaw their great future was Mr. Jay Gould, a Wall Street broker. He bought out the Tilden and Field interests and so gained control of the works. The roads are admirably managed, and their extension in various directions would greatly add to the public convenience."

COLOR PHOTOGRAPHY—"M. Lippmann has been pursuing with energy his investigations into color photography. He says that 'on the layers of albumino-bromide of silver rendered orthochromatic by azaline and cyanina, I obtained very brilliant photographs of spectra. All the colors came out at once, even the red, without the interposition of colored screens, and after an exposure of from five to thirty seconds.' He submitted photographs of stained glass windows, draperies, oranges, and a parrot, taken by electric light with five to ten minutes' exposure, in which the color is noticeable as well as the form."

THE PATH OF WAR
Telephone lines are the paths of war. Marching over them in endless file are messages that must get through.
There's no way to build more lines because materials are going into arms for men like these American para-ski troops. But there is a way you can help keep the wires clear for urgent needs.
Please don't make Long Distance calls to centers of war activity unless they are VITAL.
Remember — war calls come first!
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U. S. PARA-SKI TROOPS

OUR *Point* OF VIEW

CENSORSHIP

To THE foreign readers of SCIENTIFIC AMERICAN there is due an explanation of certain oddities which they have recently seen in these pages; to our domestic reader group there is inherent interest in this explanation regarding one of the many difficulties which war places on the publication of a magazine. The oddities referred to consisted of blank spaces in the editorial content of the magazine, sometimes only a few lines in extent, sometimes full pages and more. In these spaces, from which certain articles had been deleted, there appeared a statement to the effect that the material originally scheduled for these spaces was not approved for export by the Office of Censorship.

Compulsory censorship? Restriction of the freedom of the press? Not exactly, in this case, but, rather, a censorship set up for a war purpose and being carried on by a group of men who are doing it with a commendable sense of the responsibility which has been vested in them.

After the editor has made his selection of articles, and has carefully combed it for possible offending material, it is submitted to the Technical Data Division of the Board of Economic Warfare. In this division there has been set up a staff of experts in various fields whose job it is to go over the submitted material and to judge whether or not it complies with the general rules. If it does, these experts pass it on to the Office of Censorship where the material is once more reviewed. If it again passes the official scrutiny, a license is issued to the publisher and he is permitted to export the material—to send it out to his foreign subscribers.

But suppose the two groups of governmental officials mentioned above do not agree with the editor's selection? Then the license is issued with restrictions: The offending material must be "excised" from all copies that are to be mailed abroad. How to excise it is left up to the publisher's judgment. In the cases with which SCIENTIFIC AMERICAN has been specifically concerned, the directive for excision was not received until nearly press time. Thus the decision was made to run the material in those copies intended for domestic consumption and to lift the type and run blank spaces, with the notice mentioned above, in those copies to be sent out of the country. So far this has been done in two issues.

That, in essence, is the mechanics of the only compulsory censorship which has so far been placed on the press of the United States. It concerns only export copies, and therein lies the obvious futility of it all. We have not been reading too many spy stories or seeing too many movies when we state that it is our belief that every copy of SCIENTIFIC AMERICAN and of every other semi-technical and technical publication in the United States is carefully scanned, *in this country,* by foreign agents. This they do regularly, regardless of whether or not a single copy of a single informative publication is ever placed in the foreign mails by its publisher.

We are not alone in our opinion regarding the efficiency of the enemies' information collection systems. We have talked to many men directly concerned with the problems of censorship and, almost without exception, they agree that technical information originating in the United States could possibly reach enemy hands long before it could ever get there as a result of copies of magazines being mailed to foreign addresses. (The reader should bear in mind of course, that no magazines can be transmitted to enemy countries, to enemy occupied or controlled territory, or even to certain countries contiguous to enemy nations.)

Yet these men of the Board of Economic Warfare are carrying on faithfully in a thankless job. They are constantly at swords' points with publishers; they are always open to the suspicion that they are playing favorites. Yet they discharge their duties as they see them. Although they are the men who "make holes" in our copies intended for export, we have the greatest of respect and the greatest of sympathy for them in an unenviable position.

Our only hope is that someday there will come a complete realization of the futility of the present export censorship and that these technicians who now spend their days poring over page proofs will be released from this tedious process, to turn their technical talents to more fruitful fields of endeavor.—*A.P.P.*

WHERE STAND THE VITAMINS?

WHERE do vitamins stand today in sound, conservative scientific and medical circles?

Now and then the American Medical Association issues official reports in which subjects—some of them not necessarily brand new—are weighed and sifted just as if they were new. That is, detachedly. A recent report of the Association's Councils on Pharmacy and Chemistry and on Foods and Nutrition thus deals with the vitamin mixtures available in prepared form—capsules or tablets.

First, the Councils find that prolonged deprivation of vitamins does produce a variety of diseases. Advice to the physician dwells on treating these diseases first with a food diet rich in vitamins, but does not condemn or even look askance at supplementing the diet with appropriate vitamin preparations.

Still unremedied, the Councils find, is the fact that some of the vitamin mixtures are badly balanced—enormous doses of Vitamins A and D and relatively insignificant amounts of riboflavin (B_2). For the adult, the minimum daily requirement of vitamins it recommends is: Vitamin A, 4000 U. S. P. units; B_1, 1 mg.; riboflavin, 2 mg.; C, 30 mg.; D, 400 U. S. P. units. It also asks for more informative labeling and for restrictions of advertising claims.

These are total vitamin intake requirements. If the layman who is not under a doctor's care can obtain all of these direct from his diet, we shall not become a nation of pill gulpers.—*A.G.I.*

Personalities in Industry

EDGAR STALEY GORRELL

By the time he was 21 years old Edgar Staley Gorrell had accumulated a diploma from Baltimore City College, a B.Sc. and a lieutenancy from West Point, and an insatiable desire to learn all there was to know about aviation. During the next eight years of his extremely active life, the young officer not only satisfied his appetite for knowledge of flying, but he also acquired an M.Sc. from Massachusetts Institute of Technology, a colonel's commission in the Army, the Mexican Punitive Expedition medal, the British D.S.O., the French Legion of Honor, and the Victory and Distinguished Service medals from his own country.

These awards are readily understandable when it is known that after two years in the infantry, the youthful lieutenant transferred to the Aviation Section, Signal Corps (now the Army Air Corps) as early as 1914, went with Pershing into Mexico, and was sent to Europe in 1917 as a member of the Bolling Commission to help determine what aerial material should be produced in the United States and what produced abroad. From that start he moved to Chief Engineer Officer of Air Service of the A.E.F., and in the course of serving on all five fronts he became successively Assistant Chief of Staff and Chief of Staff of our expeditionary air forces.

In 1920, at the ripe old age of 29, he resigned from the Army with the rank of Colonel, and for the next 15 years the automotive industry claimed his close attention. However, in 1936 the scheduled airlines agreed that their industry needed as a "czar" a man with practical flying experience, executive and diplomatic ability, scientific background, and general knowledge of aviation. Colonel Gorrell was chosen for this position and became president of the newly organized Air Transport Association of America.

Since then the head of the Air Transport Association has been a busy man. He averages 100,000 miles a year on the airlines, writes one or more dynamic pamphlets or speeches a week. When he is in his Chicago office—and that has totaled as little as 65 days out of a year—his rapid-fire dictation keeps two, sometimes three stenographers well occupied. His is a powerful, constructive force in public relations, and his absolute fetish toward safety and accuracy has been successfully transmitted to every member of the industry, as attested by the records.

Now past the half-century mark, whatever the Colonel does, he still does with all his might, be it work, swimming, collecting odd bits of Lake Michigan driftwood, or gardening at his home in Lake Forest, Illinois. In the latter, Mrs. Gorrell, who is an aviator in her own right, joins in keen competition. There is a third Gorrell 11-year old Peter, whose laudable ambition is to emulate his Dad, and who is the pride of the Colonel's little "regiment."

Probably the achievement of which he is most proud was his membership on the Army Air Service Investigating Committee of 1934, for it was from the deliberations of that body that the G.H.I. Air Force was created (the Colonel's idea), and from which much of a constructive nature with respect to military aviation has been accomplished. Add to this the fact that Colonel Gorrell's views and comments since his association with the Air Transport Association have contributed much to the background for legislative and administrative action in civil flying, and it is easy to see why he has been termed the "spark-plug" of our civil aviation industry.

98TH YEAR SCIENTIFIC AMERICAN DECEMBER 1942

NAVY SKY-FIGHTERS

Aircraft of the United States Navy

WALTON L. ROBINSON

MODERN naval warfare is three-dimensional; gone forever are the days when sea fighting was restricted to encounters between surface ships. The navies of today fight on the sea, in the air above, and in the waters beneath. Relative strength can no longer be calculated by the simple process of totaling tons and guns; new weapons—the mine, the torpedo, the submarine, and the airplane — have made their appearance, adding many complex and unpredictable factors to the art of sea warfare.

Latest of these weapons is the airplane, an American invention which appeared just after the turn of the century. A few years later in World War I, planes were employed with some effect in the military operations, but they had little influence on the war at sea. It was not until the years immediately following the 1914-18 conflict that the possibilities of naval aviation began to be fully realized, and then only by the most rabid air enthusiasts. Like most pleaders for some special weapon, however, they overstated the case for the plane, blandly declaring that it had made battleships obsolete and would even abolish navies altogether. Actually, the plane has done nothing of the sort, but it has quite definitely established itself as another and absolutely essential weapon of naval warfare.

The United States Navy was one of the first to recognize the potential value of aircraft and today possesses what is generally conceded to be the finest air service of its kind in the world. Our naval planes are as good as or better than those of any other nation, while the training and morale of our fliers are unsurpassed. This very satisfactory state of affairs is no matter of luck; rather, it is the result of a long and painstaking development which really began in July, 1921, with the creation by Congress of the Navy's Bureau of Aeronautics. Rear Admiral William A. Moffett was the first Chief of this bureau; he remained in office until his untimely death April 4, 1933, in the crash of the rigid airship *Akron*. Under his direction our naval air arm developed rapidly and established many speed and altitude records. Three aircraft carriers were also commissioned—the old *Langley*, formerly a navy collier, and the *Lexington* and *Saratoga*, converted during construction from their original battle cruiser design. The U.S.S. *Ranger*, our first ship laid down as an aircraft carrier, was launched a few weeks before Admiral Moffett's death.

● Following the series of five analytical articles on battleships, aircraft carriers, cruisers, destroyers, and submarines of the United States Navy is this clear and concise description of our naval aircraft. We propose to follow these six inter-related Navy features with a comprehensive article on the tactical usage of each branch of our naval fighting forces, as soon as it is approved for publication by the proper authorities. The previous articles appeared in our issues for May, August, September, October, and November of this year.—*The Editor.* ●

THE various types of planes used by the Navy are officially designated by a system of letters and numerals. An initial letter or letters indicate the function or class of the plane; a following numeral, if present, indicates the model; and a final letter, the manufacturer. Following this group and set off by a dash is a numeral indicating the series or modifications of the model. Thus the designation PBY-1 indicates that the plane is a P (Patrol) B (Bomber) Y (Consolidated) -1 (First model). Any minor alterations to this basic design, such as slight changes in structure or armament, would make the new model a PBY-2. An entirely new patrol-bomber model built by the same manufacturer would, on the other hand, be designated a PB2Y-1. A modification of this model would be a PB2Y-2.

The letter "X" preceding a designation indicates that the model is experimental. This "X" is discarded when the plane goes into production. The letter "V," indicating "heavier-than-air" craft (as distinct from "Z," employed to designate "lighter-than-air" craft—blimps and rigid airships), is placed before the functional letter or letters when referring to classes of planes or abbreviating the names of air squadrons, but is omitted from the designations of individual models, as in the examples given above. Thus patrol-bombers in general are spoken of as VPB's, while "Patrol Squadron Eleven," for example, is rendered VP-11, the second functional name and its corresponding letter being dropped.

ON October 1, 1941, two months before Pearl Harbor, the United States Navy had on hand a grand total of 4862 aircraft. An additional 5832 planes were on order under the Expansion Acts of 1940-41, which had authorized a strength of 16,000 aircraft. This total was subsequently increased to 27,000 planes, while the Emergency War Program, which followed our entry into hostilities, provided for some 60,000 naval aircraft of all types. Only combatant aircraft—fighting, scouting, bombing, torpedo, observation, and patrol planes—will be discussed, however, as they are the ones which exercise a direct influence on and actively participate in naval operations.

These aircraft are of three very distinct types: landplanes, which operate

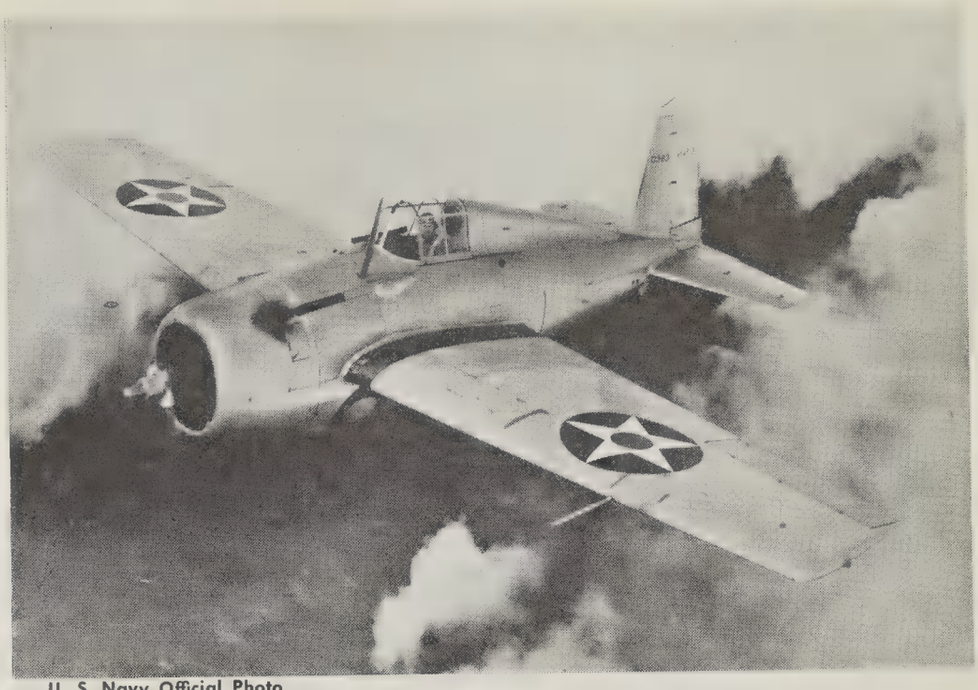
from aircraft carriers or land bases; seaplanes, which are carried by battleships and cruisers, being flown off from them by means of catapults; and flying boats, operating from coastal bases, advanced shore bases, or tenders. Carrier-based aircraft are the fighting (VF), scout-bombing (VSB), and torpedo-bombing (VTB) planes. Seaplanes are mostly of the scout-observation (VSO and VOS) type, while the big flying boats are all of the patrol-bomber (VPB) type.

The VF's, or fighting planes, are the Navy's smallest and speediest combatant aircraft. These single-seaters have two distinct missions, one defensive and the other offensive. Their primary mission is defensive: to secure control of the air above combat areas and to protect friendly planes and ships by destroying hostile fighters, bombers, torpedo planes, and other aircraft. Their secondary and offensive duties consist of attacking enemy surface warships, submarines, shore installations, and their exposed personnel with machine-gun fire, small cannon, and light bombs.

Our fighting planes in service are the products of three well-known aircraft manufacturers: the Brewster Aeronautical Corporation, the Grumman Aircraft Engineering Corporation, and the United Aircraft Corporation. Their respective identification letters are A, F, and U. All of the Navy's fighting planes, as well as most of its other combatant aircraft, are powered by either Pratt & Whitney or Wright radial air-cooled engines developing from 450 to 2000 horsepower on the take-off. A few scout-observation models, however, have a Ranger in-line air-cooled engine.

DURING 1937-40 three improved models of the Grumman F2F-1 biplane, the F3F-1, F3F-2, and F3F-3 entered service. The F3F-2 and F3F-3 models, fastest of the group, have a top speed of only 270 miles per hour. The last two-winged fighters built for the Navy, all of these planes are now obsolete and mostly employed as combat trainers.

In 1940 Grumman delivered its first monoplane fighter—the twin-engined experimental Skyrocket or XF5F-1, which is powered by two 1200-horsepower Wright Cyclone engines. The greatest secrecy surrounds this plane, but it is known to be in the 400 miles per hour class. The Navy has not announced production contracts for the model, which, as a result of exhaustive tests, is believed to be undergoing considerable modification.



U. S. Navy Official Photo
Grumman Wildcat Fighter (XF4F-3) above the clouds

Other fighters delivered in 1940 were the Brewster F2A-1's or Buffaloes. Powered by a 950-horsepower Wright, they have a top speed of 330 miles per hour and a cruising range of 1000 miles. Forty-two of them were released to Finland in 1940, being replaced by an equal number of improved F2A-2's.

In 1941 Grumman delivered its F4F-3's and F4F-3A's (Wildcats), while Brewster completed its F2A-2's and F2A-3's (Buffaloes). The Wildcats are powered by a 1200-horsepower Pratt & Whitney Twin-Wasp engine for a top speed of about 350 miles per hour. They have a cruising range of about 1150 miles and a service ceiling of 28,000 feet. Their equipment includes bullet-proof gas tanks and armor protection for the pilot.

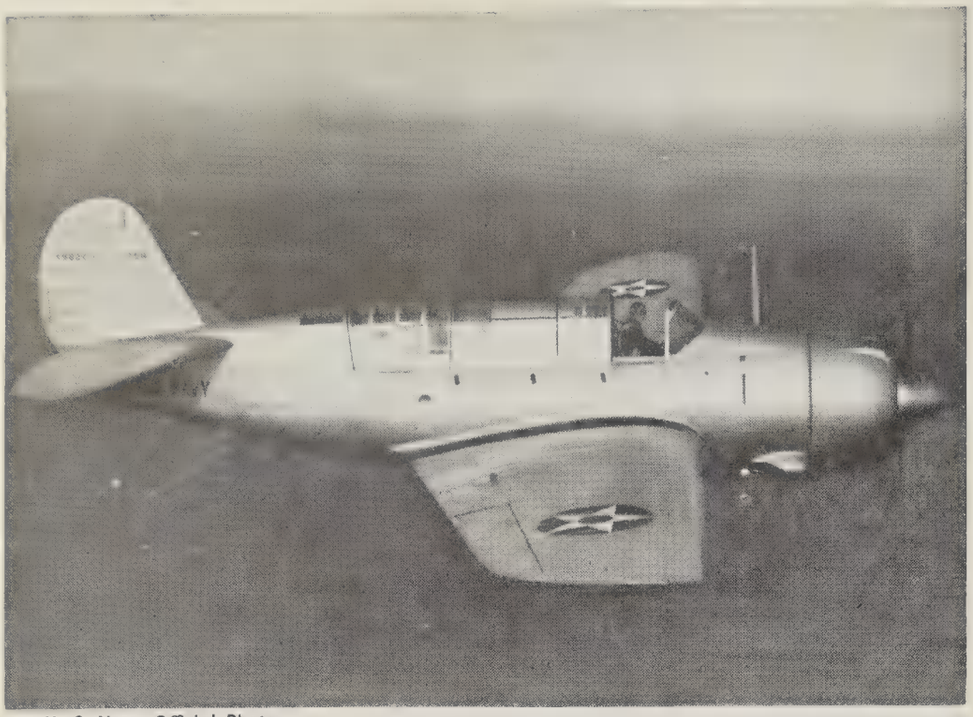
The Buffaloes have a 1200-horsepower Wright engine for a miximum speed of 360 miles per hour. They are credited with a range of over 1400 miles and a 30,000-foot ceiling. Armament comprises four .50-caliber machine guns and two 100-pound bombs. The F2A-3's are generally similar to the F2A-2's except for their folding wings. Several hundred of them were supplied to Britain and the Netherland East Indies during 1940-41.

Latest Navy fighters, delivered this year, are Grumman's F4F-4's and F4F-4B's and the Vought-Sikorsky (United) F4U-1's. All data regarding the new Wildcats are restricted, but some details of the F4U-1's (Corsairs) have been released. These planes, specially designed for carrier use, have an 18-cylinder Pratt & Whitney Double-Wasp engine rated at 2000 horsepower on the take-off and giving a top speed of around 400 m.p.h. at 35,000 feet. They are generally considered to be the Navy's best fighting planes, particularly for high altitude work.

SCOUT-BOMBING planes (VSB's) are the most numerous carrier-based type. As their designation implies, these two-seaters are intended for either scouting or bombing duties. As scouts they carry additional fuel in auxiliary tanks hung from their bomb racks, while as bombers some of them can carry a ton of high explosives. In recent years the VSB's have been built by Brewster, Vought-Sikorsky, the Curtiss-Wright Corporation, the Douglas Aircraft Company, Incorporated, and the Naval Aircraft Factory. Identification letters of the last three builders are C, D, and N respectively.

In 1938 Chance-Vought completed a number of monoplane scout-bombers —the SB2U-1's. Two more series of the model, the SB2U-2 and SB2U-3, were delivered in 1939-41. Named Vindicators, all three groups are powered by an 825-horsepower Pratt & Whitney Twin-Wasp Junior giving a speed of 257 miles per hour. Their cruising range is 700 miles. Further details have not been released for publication.

In 1938-39 Curtiss delivered two series of biplanes—the SBC-3's and SBC-4's. The former have a maximum speed of 220 miles per hour, while the latter can do 235 miles per hour. Both groups are now obsolete and mainly employed for combat training. The newest Curtiss scout-bombers and the best the Navy has, are the



U. S. Navy Official Photo
Curtiss Helldiver diver bomber (XSB2C-1) in flight

SB2C-1's (Helldivers), very fast and heavily armed monoplanes specially designed for dive-bombing attacks. Few details concerning them have been released, but it is understood that they are powered by a 1750-horsepower Wright Double Row 14-cylinder engine giving a speed in excess of 300 miles per hour. They are equipped with internal bomb stowage.

FOUR series of Douglas Dauntless scout-bombers (SBD-1, -2, -3, and 3A) were delivered in 1941. All of them are monoplanes of very similar design. Powered by a 950-horsepower Wright, they have a top speed of 260 miles per hour and a cruising range of about 1000 miles. Their armament includes two .50-caliber machine guns and several 500-pound bombs.

The Naval Aircraft Factory also completed a number of VSB's during 1941. Designated the SBN-1's, they are generally similar to the old Brewster SBA-1's, now out of service. Their maximum speed is 285 miles per hour. Although built and classed as scout-bombers, they have served on occasions as carried-based VTB's (torpedo-bombers).

THE only Brewster scout-bombers at present in service are the SB2A-1 Buccaneers, the first of which were delivered this year. As in the case of the latest Curtiss VSB's, details concerning the Buccaneers are restricted. It is believed, however, that they have very similar characteristics to the Helldivers.

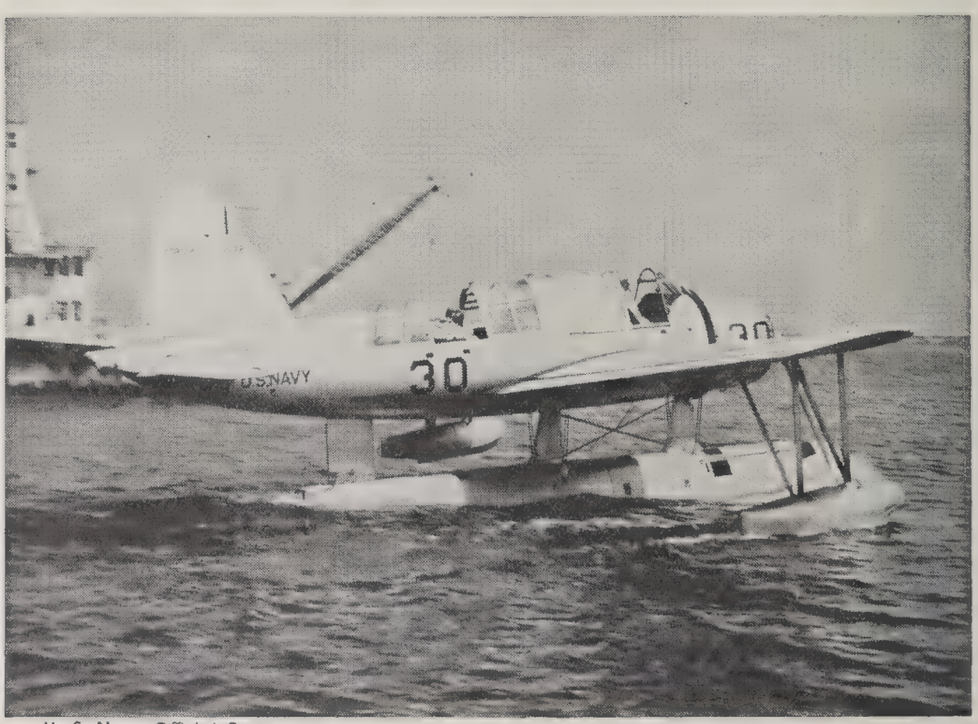
Some of the Navy's older bombing planes, designed primarily for dive-bombing attacks, are classed simply as VB's (bombers). In recent years these planes have gradually merged into the scout-bomber type described above. Torpedo-bombing planes (VTB's) are the Navy's heaviest carrier-borne aircraft and probably its most effective weapon for striking heavy aerial blows at the enemy's large naval units. Whenever possible, they make their torpedo attacks from low altitudes and close to the target. On bombing missions they remain at high altitude and drop armor-piercing or demolition bombs on warships and shore objectives.

The Douglas TBD-1's (Devastators), the first of which entered service in 1938, are three-seat monoplanes with an 850-horsepower Pratt & Whitney Engine. Their top speed is 225 miles per hour and their cruising range 1000 miles. They can carry either a torpedo or a ton of bombs.

Newest torpedo-bombers are the Grumman TBF-1's (Avengers) which have a speed of 270 miles per hour, a cruising range of 1400 miles and a ceiling of 20,000 feet. They dealt the Japanese Navy some very hard blows at Midway.

SCOUT-OBSERVATION planes are officially divided into two types: VSO and VOS. When ship-based, both types are fitted with landing floats but these can be quickly replaced by wheel gear when desired. The VSO's are primarily scouts, operate from cruisers, and have folding wings to facilitate their stowage in hangars aboard ship. The VOS planes have rigid wings and are carried by battleships, whose gunfire they observe or "spot," thereby increasing both the accuracy and range of the big guns. All of our battleships carry three VOS (observation) planes, while most of our cruisers accommodate four to six VSO (scouting) planes.

Curtiss, Vought-Sikorsky, and the Naval Aircraft Factory are the builders of our VSO-VOS planes at present in service. In 1937-39 Curtiss delivered three scout-observation models SOC-1, -2 and -3. A fourth model SOC-4, was delivered to the Coast Guard. Biplanes with a speed of about 165 miles per hour, they are now obsolete. Latest Curtiss scout-observa



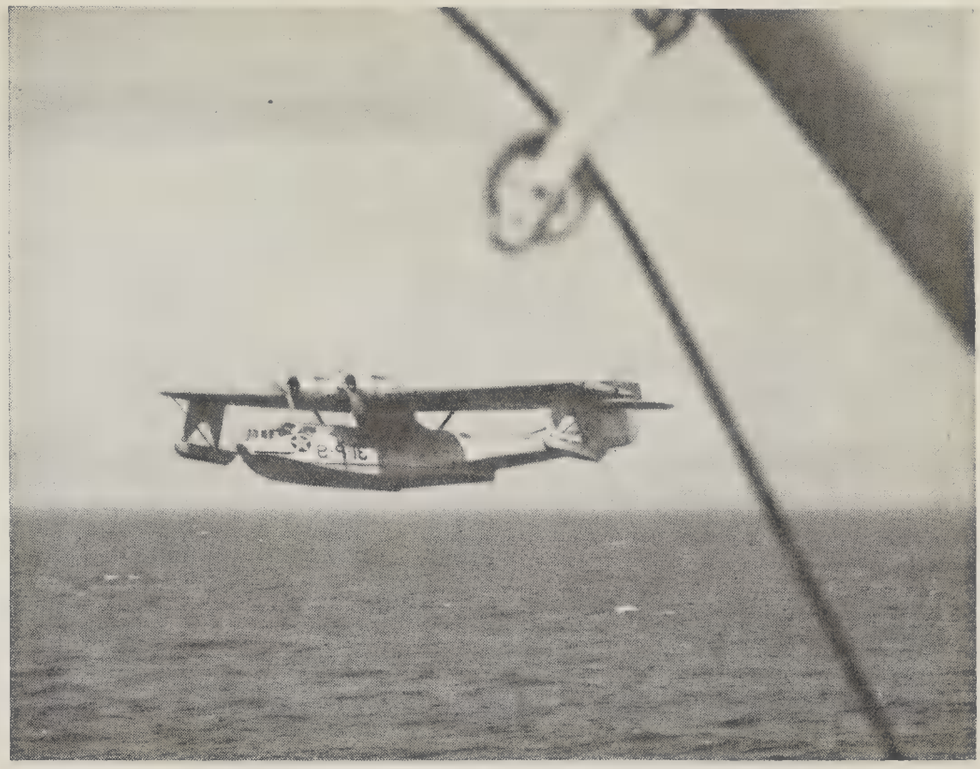
U. S. Navy Official Photo
Vought-Sikorsky training ship (OS2U-1) about to take off

tion plane is the SO3C-1 (Seagull), a two-seat monoplane powered by a 520-horsepower Ranger inverted Vee air-cooled engine giving a top speed of 200 miles per hour.

Vought-Sikorsky recently delivered three VOS models: the OS2U-1 and OS2U-2 in 1941, and the OS2U-3 this year. These planes, known as Kingfishers, have a 450-horsepower Pratt & Whitney Wasp-Junior engine giving them a 200 miles per hour speed. They are the Navy's standard observation planes.

The Naval Aircraft Factory in 1940 completed a VSO model, the SON-1, and this year delivered its OS2N-1 observation plane. The former, a low speed biplane, is now obsolete. The latter, however, is practically a duplicate of the Vought-Sikorsky Kingfishers described above.

Patrol-bombing planes (VPB's) are the largest aircraft in the naval service. Known as the "Eyes of the Fleet," their primary mission is long-range reconnaissance from shore bases or aircraft tenders and the protection of convoys from submarine attack. Their secondary mission is to operate against enemy ships or shore establishments, in which case they carry bombs, torpedoes, or mines instead of maximum fuel load. Fitted with bunks and cooking facilities, they can operate for extended periods from small tenders or advanced bases. All of them are flying boats and some have reversible-pitch propellers for maneuvering afloat.



U. S. Navy Official Photo

Consolidated Catalina (PBY-2) patrols the coast

Most of our patrol-bombers have been built by the Consolidated Aircraft Corporation and the Glenn L. Martin Company. The former's PBY-1 Catalina monoplanes date from 1937. Weighing nearly 14 tons, they are powered by two Pratt & Whitney 1050-horsepower engines for a speed of 200 miles per hour. Their cuising range is about 4000 miles and their ceiling 25,000 feet. They can carry two torpedoes or two tons of bombs and require a crew of seven. Four improved series, the PBY-2 through PBY-5, were delivered during 1938-41. The last two models weigh 15 tons and have 1200-horsepower engines. This year a number of PBY-5A amphibians, designed to alight on land or in the water, were delivered.

In 1938 Consolidated completed its first four-engined plane, the XPB2Y-1. After exhaustive tests, this experimental type passed into production as the PB2Y-2. First delivered last year, these giant Coronado aircraft weigh 30 tons, are powered by four 1200-horsepower Pratt & Whitneys, and have a range of some 5000 miles. They carry six or more tons of bombs and a crew of nine.

The Martin company delivered its first patrol-bombers in 1941. These planes, the PBM-1's (Mariners), weigh 20 tons and have a pair of Wright Cyclone 1200-horsepower engines for a speed of 225 miles per hour. A crew of seven and two 21-inch torpedoes or several tons of bombs are carried.

This year Martin completed the huge Mars or XPB2M-1, a 70-ton patrol-bomber with four 2000-horsepower 18-cylinder Wright Duplex Cyclone engines. This great flying boat has a range of over 7000 miles, requires a crew of 11, and can carry four torpedoes or a very heavy bomb load. As a transport she can accommodate 150 fully equipped soldiers Some observers regard the Mars which is still very much in the experimental stage, as ideally fitted for the regular bombing of Japan.

These, then, are our Navy's combatant aircraft in service or in production. Upon them we must depend for some time to come. New and greatly improved models will doubtlessly appear in due course, but for the present such excellent aircraft as the Wildcat and Corsair fighters, the Helldiver and Buccaneer scout-bombers, the Devastator and Avenger torpedo-bombers, the Seagull and Kingfisher scout-observation planes, and the Catalina, Coronado, and Mariner patrol-bombers must form the backbone of our hard-hitting Naval Aviation.

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HIGH-OUTPUT ENGINE

Liquid-Cooled, For Use by Navy

In an announcement foretelling a revolutionary change in naval aircraft design, the Navy disclosed recently the development of a huge new liquid-cooled aviation engine approaching 2000 horsepower.

If the Navy's use of this extraordinary powerplant, developed by the Lycoming Division of The Aviation Corporation, follows the same general line of airplane construction adopted by the Army with liquid-cooled engines, then a new series of naval fighter craft, faster and more powerful than any now on first-line duty, is in the making.

Official silence cloaks both the performance figures and future uses of the new engine. The formal announcement that it had been completed and placed on contract described it only as "considerably larger than any other liquid-cooled aircraft engine now in production," with power sufficiently great "as to compare favorably with that of the largest type aircraft engine presently in use."

The largest known air-cooled aircraft engines now used by the Navy are the 2000-horsepower units on the giant flying boat *Mars*.

A Chemist Looks At Research

Development Cost Comparisons Reveal the General Value of Research for Many and Varied Industries

EUGENE AYRES
Staff Chemist of the Gulf Research and Development Company

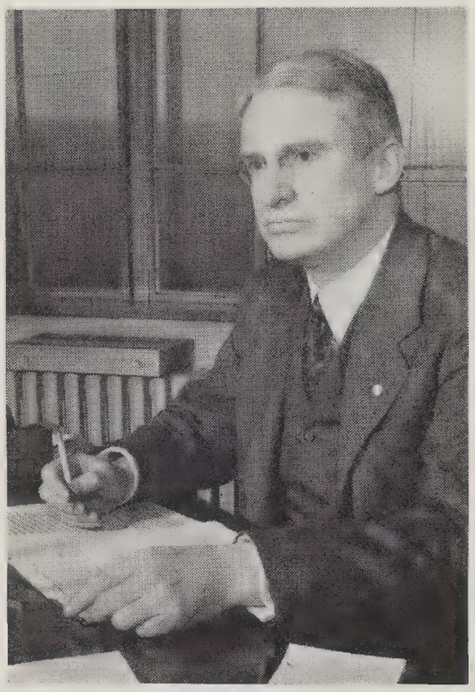
It is a curious circumstance that research, which is the most scientific of all pursuits, should be one of the most difficult to evaluate in dollars and cents. Those of us who are enthusiastic about research are apt to refer to its value in most general terms. We say it is valuable because of this and because of that—all abstract qualities—much as we would define the value of honesty as a business asset.

Lord Kelvin is often quoted as saying that "when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be." Perhaps Lord Kelvin would say that, despite the eminently scientific nature of research, its appraisal for business purposes is only dimly understood.

It is natural that no generalizations can be made concerning the monetary value of research carried out by an individual. There are notorious cases of extraordinary returns from very little in research, and other more familiar cases in which research has continued year after year without tangible return. But in organized industrial research, the element of chance is less important for several obvious reasons, among which are the number and variety of technical viewpoints and, particularly, the character of the research problems. In general, there are two kinds of research problems. On the one hand there are problems that are fruitful only if we are fortunate enough or clever enough to get a particular kind of answer, and, on the other hand, there are research problems which are fruitful without regard to the answer.

A paper presented before the Division of Industrial and Engineering Chemistry at a meeting of the American Chemical Society.

Suppose we have reason to believe that a certain organic compound might have useful properties as an antioxidant. We do a lot of work to find out how to prepare this organic compound and then we test it to see if it has the desired antioxidant quality. If the answer is "yes," we may balance the cost of research work on this problem against the value of the antioxidant, but if the answer is "no," we may have no economic justification for this research expense. Here the value of the research depends upon the kind of result obtained. But suppose we



The author

undertake to determine the optimum conditions for a process in order that we may know how to design a commercial plant. Here the result has the same value regardless of the conditions which are found to be optimum. A considerable proportion of industrial research is concerned with this second type of problem, and from the voluminous experience of research laboratories in many industries, certain numerical criteria are beginning to emerge.

It is probable that no two research laboratories would agree in detail on the average relationship between the different elements of cost of development, but they would probably not be very far apart. These cost relationships have been formulated by economic studies of many different sorts. For example, a company found it necessary to go into the manufacture of a new chemical in a hurry. There were no large-scale precedents for this operation but two good process ideas were offered by the Research Department. Because of the emergency, it was decided to commercialize one idea without any research, while the second idea was carried in orderly fashion through laboratory and pilot plant. Despite the delay occasioned by months of research, the second idea resulted in a smoothly operating plant before the first and at much lower development cost. The first idea was then sent back to the Research Laboratory and a year later superseded the second.

In another case, illustrating another way of going about it, a new process was commercialized from laboratory data without pilot plant research. A few years later a new plant of the same size was designed and built from data secured from the first plant.

From these and dozens of other cases, it is possible to come to some general numerical conclusions which, being averages, apply to no specific case with any accuracy, but which may apportion development costs in the correct order of magnitude for a majority of industries and companies. Here are three generalized cases:

	Units of Cost		
1. Laboratory Research	1	1	0
2. Patent Prosecution	1	1	0
3. Pilot Plant Research	5	0	0
4. Excess Design and Construction	5	15	20
5. Getting Process in Operation	25	50	65
Total Development Cost	37	67	85

"Getting Process in Operation" is the part of development cost that comes after the commercial plant is built. There are some companies which always figure this cost because it is the largest element of development expense and because it affords one of the best measures of technical management. But some other companies permit this cost to be absorbed in operating expense and do not worry about it. This cost may be figured in many different ways but perhaps most conveniently by subtracting the operating profit for the first year of operation from the operating profit for the second year of operation, making indicated adjustments for proper comparison and including, of course, such items as structural changes and losses of materials.

"Excess Design and Construction"

cannot be figured so easily, but can be estimated by competent engineers. *Total* design and construction cost cannot be regarded as development expense because thoroughly commercialized plants also must be designed and built. But, because of technical uncertainties, it always costs more to design and to build a new process than an old one, and the difference is development expense. The more we know about a process before we start to build, the smaller this difference and also the smaller the cost of getting the plant into operation.

Every authorization for plant construction covers not only investment but also a proportion for development expense; but this proportion cannot be ear-marked as such for the very good reason that it cannot be predicted in advance.

The first column expresses the relationship between cost elements which perhaps may be regarded as ideal and, therefore, as showing a minimum total for the average research project. Laboratory research and patent prosecution are indicated as of the same order of magnitude. Pilot plant expense is five times as high as laboratory expense. "Excess Design and Construction" is made equal to pilot plant expense because experience indicates that this is about as low as competent research can bring it and "Getting Process in Operation" is five times as great for the same reason.

THE most significant comparison is between the columns. Without any research, the total development cost is about 2.3 times the total cost with adequate research. Laboratory research without pilot plant work figures 1.8 times the ideal.

It is interesting to apply these ratios to special cases. For example, a chemical company, during a certain period, spent on the average about $3,000,000 per year for process development. During that period this company did no laboratory or pilot plant research on these processes. The $3,000,000 was made up of "Excess Design and Construction" and "Getting Process in Operation." According to the table, if this company had done $175,000 of pilot plant work per annum, it could have reduced the total development expense for these processes from $3,000,000 to $1,300,000 per annum. This would have meant a saving of $1,700,000, or nearly 1000 percent profit from research investment.

This conclusion may well be absurd. The table can be very wrong in specific cases but, on the other hand, it can be wrong in either direction. The conclusion noted may very well be correct.

Regardless of accuracy of application, the generalized figures point toward some interesting conclusions:

(1) Patent prosecution and laboratory research are almost negligible portions of total development expense.

(2) Total research, including adequate pilot plant work under the most favorable conditions, figures around one-fifth of total development expense.

(3) The minimum development expense is associated with adequate research expenditures.

(4) Research is about the most profitable investment that can be made.

The question is sometimes raised: Can we avoid development expense by the installation of processes developed by others? The answer to this question is clear. We can avoid the small parts of development expense, but we usually cannot avoid the large ones. Many cases can be pointed out in which a company has had lower development expense on processes purchased from others, but there are many other cases in which the development expense has been actually greater. Unless a process has already been thoroughly commercialized, whether a purchased process costs more or less than an independently developed process depends primarily upon the quality of the pilot plant work. Certain purchased processes have cost a chemical company far more for development than if they had passed through the company's own laboratory and pilot plant because the preliminary work that had been done by others failed to provide sufficient data for economical design and construction. In general, the only cases in which we can avoid the major part of the normal development expense of new processes are those in which processes have been operated for a sufficient time to iron out all the kinks. But in such cases processes are likely to become obsolete about the time we get them into operation.

TECHNICAL obsolescence must be regarded as of the utmost importance in the present argument. If we pay a million dollars as paid-up royalties for a certain process, this may not seem to be a serious expense if we can assume that this process will not become obsolete. But this is frequently not the case. By the time we get this process in operation, it will be somewhat obsolete, and by the time we install its successor and get it into operation this also is likely to be obsolete. Paid-up royalties cannot be regarded as nonrecurring expenses because technical obsolescence sees to it that such expenses recur with dismal regularity.

It appears that process research should be justified (1) by its saving of many times its cost by the reduction of the other greater development costs, and (2) by its effect upon the vital element of timing. Either one of these reasons is sufficient in itself and it is unnecessary to include the reason that research may enable us to charge royalties or to be immune from paying royalties. This last factor has to do not with the justification of research, but rather with the justification of patent prosecution. There is no reason to compare the cost of research with the cost of royalties. The comparison should be made between the cost of patent prosecution and the amount of royalties received plus the amount of royalties which otherwise we would have to pay.

ROYALTIES are normally set as high as the traffic will bear. The only reason royalties in general in the chemical industries are moderate is because competitive research has prevented any company from securing a monopoly on any important process. This makes the royalties themselves competitive and the company with the strongest patent position will either receive royalties or, if it does not wish to follow the necessary procedure for securing licensees, it will at least pay the minimum royalties. The royalties never seem very large when they are figured on a unit of material, but our competitive disadvantage is measured not by the amount of royalties, but by double this amount, for while we are paying the royalties, the other company is receiving them.

The royalties paid by companies who do little research are small compared with the cost of research that would have been required to provide immunity or to balance royalties paid with royalties received, but large compared with the cost of prosecution of patents to accomplish this result. Failure to protect inventions with patents means not the saving of patent prosecution expense, but the loss of many times this amount of money.

Companies differ widely in their patent policies. One company may not be concerned with the licensing of inventions to others for royalties, whereas another company may do this sort of thing on a large scale. The less aggressive company can defend itself only with patents, and its patent position must be made stronger than that of its more aggressive competitor. This

is merely another way of saying that its technical position must be stronger than that of its competitor; for patents are, after all, merely inexpensive handles with which to wield the technical weapons effectively.

Under some circumstances, product patents can be even more important than process patents. It happens that most product patents in the chemical industries now refer to relatively small volume products, but there are some important exceptions. Here again research is justified, not by immunity, but by getting products on the market before instead of after our competitors. If we grant that research expense can be justified in this way, it is proper to balance against royalties only the expense of patent prosecution.

Product patents are of more value to the company with the less aggressive patent policy than to the company with the more aggressive patent policy because it takes more good patents to defend than to attack. Furthermore, there are more offensive patent alliances than there are defensive ones.

The evaluation of research in accordance with the foregoing principles requires a certain measure of optimism, but this is, after all, the same sort of optimism that inspires a company owner to believe that his company can survive as a business enterprise. For only through successful research is ultimate survival possible.

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New Glass For Precision Optics

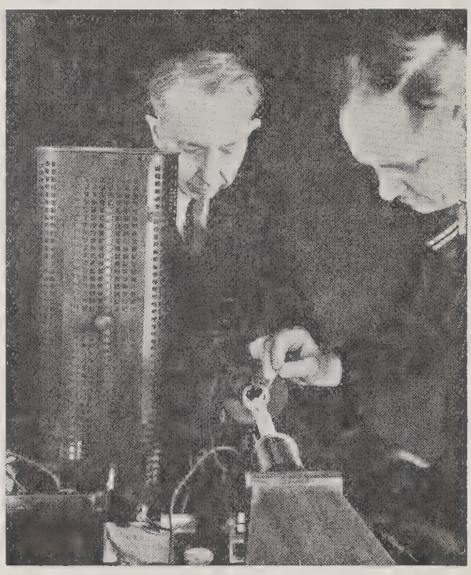
Compacted Glass, Made by a Secret Process, Makes Possible New Accuracy in Lens Manufacture

THROUGH the development of a new, scientifically controlled process of heat-treating optical glass, mass production of precision lenses—the "glass eyes" of microscopes, projectors, and other optical instruments—is now possible, according to Dr. E. D. Tillyer, research director of the American Optical Company.

The new technique, Dr. Tillyer declares, is significant because it eliminates production delays and many of the rejections which were previously encountered in manufacturing complex prisms and precision lens systems for which there is an urgent military demand. The process, he states, produces compacted glass — glass at maximum density and with maximum light-bending power—that is perfectly homogeneous throughout its entire structure. This optical uniformity simplifies the mass grinding and polishing of precision optics and prisms because their optical performance can now be made so accurate that reannealing or hand correcting is unnecessary. The process also stabilizes the glass so that future changes in its performance do not take place as the years roll by.

This stabilized glass, Dr. Tillyer reports, is definitely superior to that made previously, as shown by a precision laboratory test which determines the exact performance of an optical system. The new heat-treating technique is now being used by the optical concern's scientific instrument division, Spencer Lens Company, in the production of military optical instruments.

In explaining the process, Dr. Tillyer points out that glass can perform queer tricks. For example, a cut-glass goblet suddenly cracks for no apparent reason. Difficulties are encountered in matching the several glasses used in making bifocal lenses for near and distant seeing. The optical lens systems of precision scientific instruments may lose their accuracy after years of storage because a change of light-bending power (refractive index) takes place.

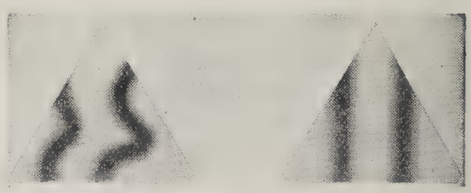


Studying the expansion characteristics of the new compacted glass by means of comparison with a standard alloy

To determine the reason for these imperfections, it was assumed that something was lacking in the glass annealing picture. The commonly accepted practice was to bring glass to a certain temperature range, keep it constant for a specified time and then let it cool slowly. This procedure actually did eliminate mechanical strain—a condition that could be revealed by polarized light.

But in addition to removing strain it was believed that the atomic structure of the glass should also be perfectly packed and perfectly settled during annealing so that the maximum light-bending power would be achieved. Tests showed that there were times when glass was not perfectly packed even when the strain had been eliminated. The production of a glass that was perfectly packed throughout its entirety seemed the answer to the problem.

Accordingly, Dr. Tillyer photographed the behavior of various specially treated sample glasses under heat in comparison with a standard metallic alloy of known thermal expansion. After a study of the film, a graph was plotted that not only showed the range commonly used in ordinary strain annealing, but another point



Typically poor glass result, often obtained with old forms of annealing, at left, compared with new glass at right. Lines indicate that refractive index is not constant throughout glass at left

which looked as if it might bear investigation. (The details of this new time-temperature cycle for annealing optical glass are a military secret and cannot be revealed.)

To investigate the new critical point in actual practice, tiny glass specimens were placed in three electrically-heated "thimble" furnaces, so insulated that the temperature could be controlled closely.

Measurements showed that glass maintained at the temperature indicated by the new theory and selected from the graphs reached a maximum index of refraction (light-bending power) higher than that usually reached in the older accepted manner of annealing. The glass seemed to be perfectly packed — completely homogeneous. For comparison, these thoroughly compacted glass specimens

were held at temperatures above the new annealing range. These samples lost some of their compactness, and their refractive index was lowered.

Bolstered by this mass of pertinent information, the new annealing process went into actual production. Results were the same. The glass was perfectly homogeneous, as revealed by a prism interferometer test. This means, according to Dr. Tillyer, that the day of "hit or miss" annealing is over—that a regular time and temperature schedule can be set up and followed with the result always as anticipated.

Precision lens systems can accordingly be manufactured without glass production delay and with the certainty that the glass will remain homogeneous permanently.

• • •

WORKERS—The number of research workers in the petroleum industry is now about 6000, of which about 45 percent are highly trained scientific men. There are 563 research workers for every 10,000 wage earners in the refining branch of the business, or almost twice the ratio in the chemical industry.

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RESEARCH CONTINUES

Machine-Gun Manufacturer

Invades Other Fields

When, in 1941, J. Russell Maguire, President of the Auto-Ordnance Corporation, manufacturers of the Thompson Submachine Gun (the "Tommy Gun"), realized that there was a definite need for research in other and somewhat allied fields, he did something about it. This realization was the beginning of a systematic effort to assemble a staff of highly competent engineers, chemists, and physicists for the express purpose of conducting research along well defined lines that bear closely on many phases of our war activities.

Less than a year later the rapidly growing research staff was housed in permanent quarters in Connecticut where they are provided with every essential for the research and development work which they are doing in fields directly connected with the total war effort. Some of the endeavors include: improvement of the present submachine gun as well as the development of new types of guns; work on an asphalt process for speedy laying of airport runways and roads under severe conditions; perfection of methods of de-bulking dehydrated foods for economical shipment to distant points; research in the broad field of electronics.

That the manufacturing activities of the Corporation have been eminently successful is evidenced by the Army and Navy "E" Award recently received, of which Mr. Maguire and his staff are justly proud.

MAGNESIUM RECLAIMED

By New Welding Method

Using Helium

Much strategic magnesium metal, already fabricated but with small defects, now can be quickly and easily restored to usefulness, thanks to a new fusion method of welding which was brought about by the close wartime co-operation of two major American industries. This new method of fusion welding, which takes advantage of the peculiar properties of helium, an inert, non-explosive, non-flammable gas, is the result of joint development by The Dow Chemical Company and Northrop Aircraft, Inc. Of particular interest at this time of rush war production is the fact that vital aircraft sand castings, some of which were formerly discarded because they did not meet standard specifications, now can often be reclaimed by this advanced method.

As magnesium, lightest of all structural metals, is an essential material for the construction of airplanes and other military equipment, the new helium arc method for welding magnesium alloys has an important bearing on our war production progress, according to Dow spokesmen. Its advantages over other methods of joining are the elimination of rivets, ease of operation, and greater speed of production over a wider range of design. These results are possible because the electric arc applied to the parent metal is shielded by a blanket of inert helium gas which prevents oxidation of the molten weld metal. Oxygen cannot penetrate the helium "envelope."

SKIN HEATER

Solves Sheet Metal

Wrinkle Problem

Heat therapy has moved out of the hospitals and into the aircraft industry through a recent development at The Glenn L. Martin Company. A major difficulty in the riveting of aluminum "skins" over spars and ribs to make wings has always been the unavoidable wrinkling and buckling of the skins under the pounding of riveting hammers. The wrinkling and buckling, even though slight, interfere with the smooth flow of air over and under the wing.

In the system of "heat therapy," devised by Harry F. Kniesche, Assistant Factory Manager at the Martin plant, the various sheets of aluminum that make up a skin are riveted together on a wood frame that has the shape of the wing. The skin, full now of unavoidable small buckles and wrinkles, is then laid on the wing of the ship. The skin heater, which might be described as an oversized version of the electric heating pad which people apply to a sore back, is laid on top of the skin. The heater fits snugly, for it has the exact contour of the wing.

The heat is turned on. In a few minutes the skin has a temperature of 140 degrees, which causes enough expansion to rid it of all wrinkles and buckles. While rheostats hold the temperature constant, the skin is quickly stitch-riveted round the edges and along the ribs. Then the heater is removed and the skin shrinks as taut and unwrinkled as a drum-head.

In ridding skins of wrinkles and buckles the "skin heater" has cleared up a troublesome problem of wing construction. At the same time, because it allows a whole skin to go on in one riveting operation, it has helped speed production.

SELFCONTRACTOR

Company Takes Over When

Subcontractor Fails

By acting as "subcontractor to itself," the new Westinghouse Merchant Marine Division has slashed nearly a year from the tooling time required for quantity production of 30-ton gears to drive new war cargo ships. This situation was brought about by the fact that an over-burdened machine tool builder, although able to design the massive gear-cutting machines, lacked the plant capacity and manpower to finish and assemble them within 12 months of the time Westinghouse needed them. The machine tool builder was asked to send the large parts of the machines to Westinghouse, where they were assembled. As a result, production of ship gears was started nearly a year ahead of the time this would have been possible had not the company undertaken to become subcontractor to themselves.

Some of the "bull" gears that will be made on these machines — gears that are coupled directly to a ship's propeller shaft to drive the vessel — are more than 12 feet in diameter. Yet each of their 693 teeth must be

machined to an accuracy of three ten-thousandths of an inch. This means that the "hobbers" — the machines which rough and finish-cut, or "hob" the gear teeth — must be built to tolerances that are even finer. If even minute errors were allowed in the cutting of these teeth, they would make so much noise under the pressure of thousands of horsepower from

Air conditioned for accuracy

the ship's turbines that sound detecting devices on enemy submarines could locate the ship in the dark and from great distances. This gear-cutting is so precise that each gear hobber is enclosed in a special air-conditioned room in which temperature and humidity are rigidly controlled.

WORN-OUT TOOLS

Can be Salvaged and Put Back Into Service

WITH the huge production of war equipment causing a heavy drain on supplies of metals, automotive companies are greatly accelerating their salvage and conservation activities. For example, the shortage of cutting tools, which is far more serious than most people realize, has led to development of reclaiming methods that in peacetime would be prohibitive in cost.

An ordinary tap, of the type which you once could pick up at the five-and-ten-cent store, now takes two months to replace. It takes six months to get milling cutters today, and to get such a part as a taper reamer for one standard type machine tool requires three-quarters of a year.

Thus, the salvaging of tools now on hand becomes a definitely sound practice, for monetary savings are relatively unimportant, when values are measured in terms of life-and-death as they are in wartime.

A new method of restoring a worn-out forming tool, as a specific example, costs more than it would to replace with a new tool, but through use of such methods, thousands of pounds of cobalt steel are being saved. The worn-out tool which, in normal times, would be ready for discard, is first annealed and forged to restore size and shape. It is then machined, heated, and quenched to produce a new tool to which grinding, the final step, restores polished surfaces.

Along with the reclaiming processes, all plants are urging workers to use great care in handling precious tools. Broken tools are conspicuously displayed with dramatic explanations of the cost of such waste in terms of time and effort.

Time and labor are, of course, the chief values to be considered now, but waste can still be measured in monetary values. In such terms it costs $40 for tools to produce one airplane propeller. And for every airplane engine, which requires from 15 to 20 cutters alone, the tooling cost ranges between $800 and $1200.—*Automotive War Production.*

PIPE LINE

Pipe Protected from Corrosion by Asbestos Wrapping

THE new 24-inch war emergency pipe line, now being constructed from Longview, Texas, to Salem, Illinois, is the largest-diameter line carrying crude oil ever built and will establish records, both for size and speed of construction.

Since steel must be conserved by every means possible, this underground line is protected from corrosion by a layer of a special asbestos felt, the wrapping being done speedily and with precision by a machine which first applies a waterproofing coating as the pipe revolves.

ARC WELDING

Looks to Bright Future

THAT war industries have only just begun to gain the benefits of modern arc welding is shown by a recently completed industrial study of this method. This study also definitely indicated that further applications of the welding process will eventually slash millions of dollars off the United Nations war bill and will cut by 30 percent the time required to produce ships and planes.

Furthermore, it now appears that arc welding will provide the means for turning out vitally needed naval and military equipment which is more combat-proof than at present; at the same time welding should be able to save an average of three hundred pounds out of every ton of steel now going into war production.

The industrial study of welding, previously mentioned and on which the above statements are based, has been carried on by the James F. Lincoln Arc Welding Foundation. From that organization also comes the prediction that the arc welding process has virtually an unlimited field for further applications. Many industries which have adopted welding in war production will doubtless continue its use after the war, thus broadening the applications of the process in civilian production, according to the Foundation.

AIR CONDITIONING

Reverts to its Original Conception

THE action of the War Production Board in asking department stores, theaters, hotels, and office buildings with air-conditioning equipment above 100 horsepower to "volunteer" such equipment for "active duty" in war production factories should serve to eliminate from the public mind the misconception of air conditioning merely as a "comfort" industry, according to Dr. Willis H. Carrier. "It is seldom recognized that air conditioning had its inception in industry as a production tool. Nor is it common knowledge that the greatly expanded production facilities of Carrier Corporation, and others in the field of air conditioning and refrigeration, are today devoted 100 percent to production for war industries," Dr. Carrier says.

"Not only is low temperature refrigeration equipment essential to the production of certain types of synthetic rubber, as pointed out by Donald Nelson in his request that stores and others 'volunteer' their equipment, but air-conditioning equipment serves a myriad of other war production requirements.

"Air conditioning, for example, makes possible a high degree of accuracy where work to close tolerances is called for. Thus, it helps insure the amazing accuracy of bombsights and firing devices. In addition, air condi-

tioning serves in the production of powder, in the loading of shells, in the production and processing of photographic film, in the manufacture of lenses and fine optical instruments and in countless other ways," Dr. Carrier points out.

AMMONIA

How This Common Chemical Aids Many Industries

AMMONIA, common to the household for cleaning woodwork, tiles, and windows; to the first-aid kit as a stimulant; and to the ice factory as a refrigerant, is an indispensable war material.

There are at least 2000 industrial uses for this chemical. Ammonia, for instance, is an ingredient basic to the manufacture of explosives for bombs, torpedoes, shells, and cartridges.

It hardens metals for vital parts of airplanes, tanks, and guns. It helps vulcanize important rubber articles. It is used in making nylon. It enters into the manufacture of fertilizers. It is employed in one process for the manufacture of "Lucite" methyl methacrylate plastic for the noses, gun turrets, navigation "blisters," and other transparent sections of fighting airplanes.

Synthesized by Du Pont and others from the elements of air and water with the aid of coal, ammonia simply is one part nitrogen—nitrogen is four-fifths of the air we breathe—chemically combined with three parts of hydrogen, a constituent of the water we drink.

Ammonia plus oxygen produces nitric acid. All military or commercial explosives require nitric acid. Furthermore, nitric acid enters into the manufacture of cellulose nitrate plastics, which have many military applications.

Gaseous ammonia flowing across heated steel under proper conditions imparts a hard, wear-resistant surface over the soft core without changing the dimensions of the metal. This process, called "nitriding," is necessary to many metal parts for airplanes, tanks, guns, and ships.

Ammonia helps in refining petroleum products. Crude petroleum contains acids harmful to stills, and these acids are neutralized by the addition of small amounts of ammonia.

The effectiveness of chlorine for destroying bacteria in drinking water is materially increased by the presence of ammonia. This combination reduces the objectionable odor and taste associated with chlorine and has a more prolonged sterilizing action than chlorine alone.

In fertilizers, ammonia is used for the ammoniation of super-phosphate and for the manufacture of urea and of sodium nitrate—synthetic Chile saltpeter.

Synthetic urea, made from ammonia and carbon dioxide, is basic to the manufacture of ammonium sulfamate, the new industrial chemical used for flame-proofing workmen's clothes, uniforms, and other textiles. Urea-formaldehyde plastics have numerous military applications.

Ammonium carbonate, a compound of ammonia, is one of the materials used to form the "bubbles" in sponge rubber. Mixed with the rubber, this chemical decomposes under heat and forms a gas which "blows the bubbles."

Ammonia is used in the manufacture of vat dyes, and in wool scouring to remove fats, waxes, and dirt. Long and varied is the list of achievements of this relatively inconspicuous chemical.

FOUNDRY WORK

Is Important Factor in Nation's War Production

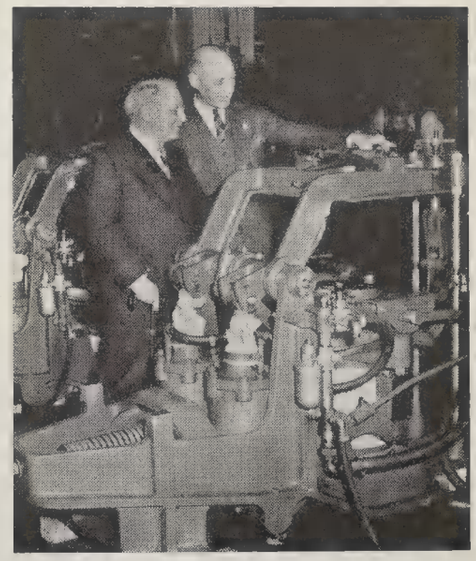
THE art of making moulds and pouring molten metal into them is ages old, so the spotlight is often taken from it by new and spectacular machines when figures for increased efficiency in mass production methods are given out. But during the last decade or two, very few industries have increased their over-all efficiency to such a degree as has the foundry industry.

Mechanization has greatly speeded up almost every foundry operation. Conveyor lines do many laborious jobs of moving moulds and materials. Machines condition and deliver sand to the foundry's moulding stations.

Not the least among the contributions to the efficiency of the foundry is the improvement made in moulding machines, according to The Osborn Manufacturing Company, one of the pioneers in their development.

When Osborn built its first moulding machine in 1909, the automobile industry was in its infancy and was soon to demand mass production methods that challenged the ingenuity of engineers. Everything in the foundry was done by hand. Completion of three of four molds for engine blocks was a day's work for a moulder and his helper. The moulders shoveled their sand, tamped the sand around the patterns, rolled over the moulds, drew out the patterns—all by hand. This was a tedious process. The percentage of scrap was high and castings made under these conditions lacked uniformity.

The moulding machine was revolutionary. Today, on an automotive production line, a pair of these machines can turn out one engine block mould a minute. A tremendous load has been taken off the moulder's back. Using compressed air, and in some cases,



One of the newest moulding machines

electricity, as a source of power, the modern moulding machine rams the sand around the pattern, removes the pattern from the sand and handles the flask—all mechanically. The making of moulds by machinery conserves the human element, and the precision and accuracy of the machine is transmitted to the mould itself. The result is that castings made from such moulds are true to pattern and uniform in weight.

One of the more difficult jobs demanded of Osborn machines was the moulding of cast aluminum cylinder heads for airplanes. These cylinder heads are cast with the cooling fins as integral parts. The present demand for greater power calls for larger cooling surfaces. This means more and deeper fins. Present aeronautical design requires that the heads be moulded with the fins spaced five to the inch, and that many of them be 3½ to 4 inches deep. Those familiar with foundry practice will immediately recognize the difficulties in producing moulds so delicate, at the high working speed required.

The process of drawing the pattern from the sand without distorting the thin walls of sand between the fins called for a moulding machine built to an accuracy of a thousandth of an inch.

This demand was met, and now large numbers of a specially designed,

precision-built moulding machine are being supplied with working parts hardened and ground. These machines are capable of operating with less than one thousandth of an inch variation in the pattern draw stroke.

In addition to the cylinder heads, the modern moulding machines are playing an important role in making possible the mass production of many other precision parts, parts which meet the rigid inspection requirements necessary to qualify for a place in the finest airplanes built in the world today.

RESISTANCE WELDING

Machine Controlled by the Weld Itself

AN ENTIRELY new approach to resistance welding is made in the "Temp-A-Trol" forge welder, which makes possible combined automatic spot welding and heat-treating of alloy steels and heavy sections and permits the employment of relatively unskilled labor for spot-welding operations.

In general appearance, the new welder, shown in one of our illustrations, does not differ radically from conventional spot-welding machines. In operation, however, it employs a completely new method of control, the weld itself automatically controlling the functioning of the machine.

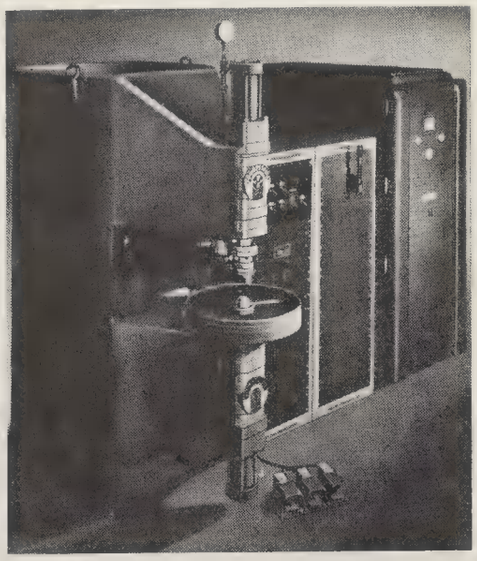
Up to now, resistance welding equipment has been operated mainly through the use of pre-selective controls regulating the amount of current and the duration of that current. The actual settings were determined by trial and error to give the best compromise for the "average" weld in a given material of a given section.

Actually, when operated in this manner, few welds are identical as to quality, because of variations in resistance due to varying metal thickness, varying induction losses as the material enters the throat of the welder, varying amounts of short-circuiting losses through previously completed welds in the same piece, variations in resistance due to the presence or absence of scale, and so on, and the gradual increase in electrode area due to normally unavoidable mushrooming.

It is for these reasons that many types of resistance welding operations have up to now required close supervision or handling by highly skilled personnel, especially when welding heavy sections and alloy steels.

The flexibility in operation of the "Temp-A-Trol" welder, in contrast, is demonstrated by the fact that—without changing the machine controls—welds of exactly equal quality can be produced consecutively in ¼ to ¼ inch, in 3/16 to ¼ inch, in ¼ to ⅜ inch, or in three sections of ¼ inch material at the same time.

In addition to this, the "Temp-A-Trol" welder can be used to automatically heat-treat the weld in the same operation. This post-heat refines the grain size of the weld, increasing



The weld controls the machine

its ductility, gives the proper grain structure, and "tempers" the weld nugget and adjacent area to any desired amount consistent with the characteristics of individual alloys. It eliminates the accepted "necessary evil" of coarse and brittle grain structures when welding alloy steels and heavy sections of other metals.

To set the controls of the "Temp-A-Trol" welder it is necessary only to determine the temperatures which will produce the best weld and heat-treat characteristics in any given material. This is a relatively simple matter. The controls of the machine are then set to values corresponding to these temperatures. After the controls are once set, the machine will automatically compensate itself and reproduce identical quality welds under wide ranges of variation as to metal thickness, cleanliness of metal, and other welding conditions.

The basic element of the control which makes this possible is the incorporation in one of the welding electrodes of a highly sensitive thermo-couple. This thermo-couple automatically shuts off the current when the correct temperature is reached, turns it on again when the weld has been cooled to the proper degree, turns it off when the correct heat-treat temperature has been reached, and so on.

Thus, instead of having a definite weld-time and welding-current with variable weld-quality, the new welder reproduces a definite weld-quality with automatically self-adjusting current and time cycles.

CUTTING OIL

Speeds Production, Lengthens Tool Life

MACHINES making parts for airplanes, tanks, ships, and guns are showing increased production and longer tool life with the use of a new industrial cutting oil recently perfected. In one recent demonstration, the new oil, known as "Cut-Aid," was used on a machine that was throwing up a plume of smoke while operating at 100 surface feet a minute. After the new cutting oil was added to the cutting lubricant already in use, there was not a trace of smoke at 300 feet a minute. At the same time, production was increased, tool life extended, and a better finish obtained on the work.

In another operation, in a prominent metal working plant in the East tool life was extended from three hours between regrinds to 11 hours in forming aluminum on a Brown and Sharpe automatic, reducing ¾" round stock to ¼". Finish improvement was declared to change from "fair" to "excellent."

"The new oil has proved ideal for machining aluminum—one of the most difficult metals to machine and one of the most important in the production of airplanes," says an official of the Gulf Oil Corporation, where the cutting oil was developed.

"With this oil, aluminum parts now can be machined so smoothly that in many cases they don't need to be polished, thus eliminating a full step in production. In shops where it has been used, machine tools cutting aluminum are setting new production records.

"The oil is also excellent for cutting magnesium and non-ferrous alloys and in many cases has set new standards of performance for this type of work including finer finish, and cleaner, sharper, and more accurately machined threads."

The new oil was developed by Gulf scientists following eight years of study and experiment on animal oils such as the oils of whales, hogs, and fish. These oils were chemically broken down and their best properties synthetically reproduced, then blended with mineral oil to produce a cutting oil with the industrially desirable qualities just described.

INDUSTRIAL TRENDS

ON THE THRESHOLD OF ELECTRONICS

WHEN this war is over—and almost all consideration of industrial trends in practically every field of endeavor must be placed on that horizon—the science of electronics is going to work at least a small revolution in many industrial operations. In order to gain now an appreciation of the possibilities of electronics in the future it is desirable to review some of the accomplishments of the past; on these accomplishments will largely be based the successes of the developments of day after tomorrow.

A broad definition will serve as a starting point for this combined review and peek into the future. The science of electronics may be considered to include all controlled applications of the electron—basic part of every atom—to the uses of man. Thus the field ranges from X-rays and ultra-violet light to the radio vacuum tube, to power controlling devices, to power converters, to star counters, to the electron microscope, to innumerable other uses in almost equally innumerable other fields.

The earliest familiar development in the then unnamed science of electronics was the X-ray, a laboratory curiosity that soon invaded the field of medicine and then branched out into many industrial ramifications. The medical uses of the X-ray do not immediately concern us here, but its invasion of industry certainly does. Thus, the X-ray has been put to inspection jobs in a myriad of factories, revealing hidden flaws, defective welds, foreign substances in packaged foods and other materials, and doing other similar jobs that, without the X-ray, would be left undone or would require destruction of the material. This latter phase is of particular importance now. Testing to destruction, a method often employed to determine structural defects, is wasteful of time and material. Substitution of the X-ray's penetrating eye for the inspection-by-destruction process speeds up operations, conserves materials, and results in greater knowledge of what has actually taken place within a given structure during fabrication.

In other ray fields there are ultra-violet and infra-red, both as invisible to the human eye as the X-ray, yet each as valuable to industry in its own way. On these rays are based lighting systems such as that using the fluorescent tube; drying methods that speed up painting, food manufacture, blueprinting, and so on; chemical processing procedures that cannot be carried out under visible light; sterilizing systems that kill up to 99 percent of the germs in the air; and so on almost to the limits of human imagination.

Just as the X-ray gave man new eyes with which to see through things, so has the electron microscope given him still another pair of eyes with which he can view the infinitely small. Already—the electron microscope is a practical development of only the last few years—many industries have gleaned much new knowledge of their products, knowledge that could immediately be applied to betterment of the products, of the processes employed, or both.

Then there are applications of the photo-electric cell to countless control jobs and of the ubiquitous vacuum tube to rectification and amplification processes, of electronic means for reducing the amount of smoke and dust in the atmosphere. These and many others are incubating in the laboratories of the world or are being reduced to practice, frequently under the hush-hush of military secrecy. It is largely this latter factor that prevents saying very much about the present-day status of electronics. Practically every development in this science, new or old, has military significance that must be kept under cover for the duration. It is no secret, however, that the push of military necessity is contributing hugely to the sum total of knowledge about electronics. When the veil is lifted, a whole new story will have to be written about the applications of this science. And it will be a thrilling story, a story that will have its effects on every civilized person.

PETROLEUM, A BASIC INDUSTRY

MOTOR and other fuels constitute, numerically, only a small part of the products that have been made available from petroleum by the continuing process of research applied on a grand scale. As a result, the petroleum industry is asuming an increasingly greater importance in today's industrial picture, with promise of even more wonders to come. Where only gasoline and kerosene grew from crude oil but a generation ago, there now sprouts such a widely diversified group of hydro-carbon derivatives as anti-freeze and alcohol, high-octane fuel and butadiene, toluene and glycerine, ammonia and styrene.

The foregoing short resume of petroleum products gives the key to future trends. Much of the development work that has made possible these products from the basic petroleum has been war-encouraged, and is going far toward assuring victory for the United Nations through the supplying of vital materials of war. This development, of course, is not going to stop with the end of the war; it is going to establish the petroleum industry as a supplier of raw materials to a host of other industries which will supply civilian needs in a manner never before possible.

War materials hold the center of the stage at the present moment. Of these, none is more dramatic than toluene, basic necessity for high explosives. Originally obtained from coal tar, toluene is now synthesized from petroleum at a rate undreamed of only a few years ago. Proof: During World War I, toluene sold for some three dollars a gallon. Today it is quoted at about 28 cents a gallon. In the same war field is ammonia, from which is made nitric acid, also needed for explosives manufacture. Ammonia is now being produced synthetically from petroleum. And there is glycerine, still another explosives constituent, which came formerly only from soap manufacture; now it also is being obtained from petroleum.

Alcohols in great variety, important in many industries as solvents and extractants, are now petroleum derivatives. So great has been the progress of this development that, it is said, some of these alcohols are being produced at such a low cost that alcohols from fermentation cannot compete with them.

Space permits touching only lightly on the products which the petroleum industry can extract from its raw material, products that, in turn, will become the bases of whole new industries in the future. Largely as a supplier of fuels obtained from crude, the petroleum industry has built up a vast integrated business that has proved its efficiency in the past. With such a background, coupled with the results of research and war-pressure, the industry as a whole should be able to keep up its rate of progress in the days of rebuilding after the war.

—The Editors

Star Populations

Have Our Existing Means of Observation Given Us True Samples of Spatial Objects?

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

In studying objects of any sort, two things are necessary: first, to be able to find the characteristics of the accessible individuals; and, second, to find out whether these individuals form a fair sample of the whole population to be investigated.

The astronomer who applies this statement to the stars may be accused of using two words, at least, in the famous Pickwickian sense—"accessible" and "population." His justification for the first is clear. Distant as the stars are, his telescopes and spectroscopes and photometers really enable him to investigate their properties. As for the second, statisticians are accustomed to speak of a population of any sort of things, animate or inanimate, which form a definite large aggregate from which samples may be selected and studied—one may have a population of stars, or even of telephone calls.

In order that the sample which is studied in detail may be fairly representative of the population as a whole, two requirements must be met. It must be large enough to be statistically significant—and free from systematic selection. In a small sample, say of a dozen, the relative numbers of objects of different kinds will depend largely on chance, and important, though unusual, types will probably not be represented; but when the number rises into the hundreds, or thousands, it is probable that the percentages of different types found in successive samples of the same size would be nearly the same.

Even though this was found by experience to be true, the samples might not be fairly representative of the whole population. The individuals to be counted have to be picked out of the great multitude in some fashion; and it is remarkably difficult to devise a method of choice which does not favor some types at the expense of others.

In statistical studies of stars, modern astronomers are usually able to get fairly large samples to work with. Spectra — the most important single characteristic—have been observed for hundreds of thousands of stars, and we have at least approximate measures of brightness for over a million.

The apparent proper motions in the heavens are known for more than 50,000 stars, and the motions of approach or recession for many thousands. The number of stars whose distances have been measured runs also into thousands, and tens of thousands more are observable spectroscopically with existing instruments.

We can measure the colors, and get a good idea of the temperatures of as many stars.

In some ways we are more limited. We can find the masses of stars only if they are doubles in orbital motion, and their distances have been measured. Even so, about 600 systems are available. Densities can be found only for eclipsing binaries, but we already have data for some 200 of them, with many more awaiting observation.

We do not know nearly as much as we wish we did about the causes of real variability in brightness; but this is not for lack of material, for thousands of variable stars are known, and hundreds of them have already been observed in a fairly detailed manner. There are certain classes of variables —for example, the novae—for which we must wait upon time to send us more to observe; but scores of these are known, and eight or ten, at least, have been observed very fully.

The white dwarfs, a few years ago, formed an exception, an obviously important class with only three or four members; but persistent search has increased the number known to more than 20.

A search for unique objects would be most encouraging among the stars with peculiar spectra. But, even here, it is noteworthy that—so far as the writer can recall—there is hardly a single object which really stands alone. It looked as if this had happened at last, when the first spectrum of a super-nova was observed and found to be different from anything known previously; but the next super-nova had almost the same spectrum.

We can see so far into space, and there are so many stars there, that there appears to be a very good chance that anything that is seen once will be seen again within a few decades or less. There is nothing new under the sun—or in the heavens far beyond it.

There is really good reason to believe, therefore, that we have already observed examples of nearly all the kinds of stars or other luminous bodies that exist in space—though the recent discovery of super-novae reminds us that "there are as good fish in the sea as ever were caught."

We must never forget, however, that this knowledge, wide as it is, is subject to severe limitations. The greatest and most unescapable of these is the obvious one that we can observe only what we can see (treating photography fairly enough as another kind of vision). Anything which is the object of astronomical study must either give out light on its own account, because it is hot, like the Sun and the stars; or shine by reflected light, like the planets and some diffuse nebulae; or give out light of its own when stimulated by the light of a near-by star, like comets or gaseous nebulae; or, finally, obstruct or absorb light, whether in general, like the dark nebulae, or in particular wavelengths like the gases in interstellar space, or in the atmospheres of the planets. There is one exception: a dark body may reveal its presence by the effects of its gravitation, producing orbital motion in a luminous companion. The faint companion of Sirius, first discovered in this way, was later seen telescopically; but there is reason to believe that some other such stars may be substantially dark. But even this exception would be unknown to us if the companion star did not shine.

This limitation excludes from our study all cold bodies outside our own planetary system. We can predict from general physical principles what they should be like. Large masses (more than 100,000 times the Earth's) must be intensely hot inside, gaseous throughout, and self-luminous—in fact, stars—unless they have reached the degenerate state of enormous density, which the white dwarfs approach. Masses 10,000 times the Earth's should settle down into a partly degenerate condition, in which they would be cold

and dark; those less than 1000 times the Earth's should, like the planets, have cores of ordinary solid matter—the larger ones with very extensive atmospheres like Jupiter, the smaller, with little or none, like the Moon; and from this there should be a continuous gradation through bodies like asteroids and meteorites down to fine dust, and at last to individual molecules and atoms. At the bottom of the scale, the particles are so enormously numerous in many regions of space that they produce observable absorption effects; but there is a vast intermediate range of size within which they are hopelessly unobservable.

From the rotation of the galaxy it follows that the total gravitating mass in it is not many times greater than that of the luminous stars. A considerable part of the excess is doubtless accounted for by the dust and gas; but there may still be a large amount in the form of dark bodies. On a census of individuals, these may be very much more numerous than the lucid stars—or perhaps not. We have only this to go on. When we try to count the stars in a given volume of space—preferably in the region close to us—we find that the great majority are fainter, and less massive, than the Sun. The numbers increase as we go to still fainter and smaller bodies—indicating that there are a great many more beyond the limits of our study.

THERE is some evidence that the rate of increase slows up, and perhaps almost stops, for the faintest stars which we can observe. We can reasonably extrapolate and say that there must be enormous numbers of bodies of one tenth the Sun's mass; but beyond the limit at which bodies would settle down into a solid, rather than a partially degenerate state, we cannot safely estimate.

We have as yet no idea at all why or how so much of the matter in the galaxy ever came to segregate into huge lumps like the stars. It is in fact hard to see how this could happen, if we start with the conventional assumption that the matter was "originally" distributed with rough uniformity through galactic space. On this basis, the stuff that ultimately formed a star would at first have been distributed through a volume at least a light-year in diameter. Unless the relative motions within this scattered assemblage were exceedingly small, the mass, when it shrank to the dimensions of a star, would be rotating far faster than the average star—indeed, it would have too much rotational momentum even to form a wide binary pair.

Yet, if the galaxy as a whole was rotating, as it does now, about a central condensation containing a considerable part of its whole mass, the attraction of this condensation would pull apart a configuration as exceedingly tenuous as that just described, and prevent it from condensing at all.

We do not know, of course, whether, when the stars were formed, the galaxy—or the matter which grew into it—was of its present size. The theory of the expanding universe points the other way. But, in our complete ignorance of what actually happened, we have no basis at all for even guessing how many smaller masses were formed in the same process.

THIS we do know: our methods of observation give an exorbitant, and almost incredible, preference to the stars of great mass and luminosity. Our capacity for observing a star depends not on how bright it *is* but on how bright it *looks*, and hence very largely upon its *distance*. The stars visible to the naked eye, for example, run down to about the limit of spectroscopic observation in full detail with high dispersion. To be thus visible, a star of the Sun's real brightness must lie within a distance of approximately 50 light-years—and we find a considerable number of these. But a star of 1/100 of the Sun's luminosity will be visible without a telescope only if it lies within five light-years. There are dozens of stars of about this brightness within 50 light-years, but a five year radius occupies only a thousandth part of the volume of the larger sphere, and it is not surprising that we do not find one within it. Inside this small sphere, we know of only three stars — the bright double Alpha Centauri, and its very faint distant companion often known as Proxima Centauri. This tiny star is but 1/25,000 as bright as the Sun.

If, on the other hand, we seek stars a hundred times brighter, in reality, than the Sun, we can see with the naked eye all that are nearer than 500 light-years. Our vision ranges over a thousand times greater volume of space than for stars like the Sun. If they were distributed in space as thickly as stars of the Sun's brightness, our list of stars visible without a telescope should contain a thousand times more of the brighter sort than of the fainter. This is remote from the facts; something like half the stars in question belong to the brighter group—or those still brighter, and one or two percent to the fainter group. In our list of "bright stars" those of high luminosity are therefore preponderant in the proportion of (roughly) 30 to 1. But, when we apply the obvious correction necessary to pass to the numbers of stars in the same volume of space, we find that the fainter stars are in an even larger majority.

The brightest super-giant stars, such as Rigel and Alpha Cygni, exceed the Sun 10,000 times or more in brightness. Such a star would be visible to the naked eye at a distance of 5000 light-years. Among the 22 apparently brightest stars there are the two super-giants just named, and only two which are comparable in real brightness with the Sun—Alpha Centauri and Procyon. This is a small number to argue from; but if space were uniformly filled with stars it would indicate that the super-giants were about a million times less frequent, in a given region of space, than stars like the Sun. This is an exaggeration for two reasons: first, a distance of 500 light-years extends on both side of the galactic plane, into vast regions where the stars are thinly scattered; second, at these great distances we must reckon with the absorption of light by the thin dust-haze which fills the galaxy and makes remote stars look fainter than they otherwise would.

MAKING a liberal allowance for these, it nevertheless follows that the necessary limitation imposed upon us by the selection of stars bright enough to observe gives the super-giants an advantage of at least 10,000-fold against stars as bright as the Sun, and of many a billion times against the faintest dwarfs.

We must therefore be cautious about the interpretation of direct counts of the stars. For example, almost all the stars which present marked peculiarities in their spectra are found (when we can investigate the matter) to be of high luminosity. The assumption that peculiar spectra in some way not yet understood were naturally associated with a great real brightness is tempting. But if one in a thousand of the highly luminous stars is peculiar, we shall stand a good chance of finding not one, but a good many such stars among the million stars which appear brightest in the sky, and are visible in a small telescope.

The stars of one percent of the Sun's real brightness will constitute but a very small fraction of these stars (since we can see them only when they are near us) and an equally unusual peculiarity may stand a very good chance of being missed altogether for lack of an adequately large sample to study.—*Princeton University Observatory, October 1, 1942.*

The Folsom Mystery

Its Solution is Largely Contingent on the Solution of Another Mystery

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No mystery in American archeology has been more fascinating than that of the Folsom culture. In the 15 years that have elapsed since the original site was excavated at Folsom, New Mexico, archeologists have diligently pursued every clue that might shed a ray of light on the shadowy "first" Americans. Their subsequently discovered sites, scattered over a wide area in the High Plains region of the United States, reveal little about them except that they were hunters of animals long since vanished: extinct American camels, bison larger than the historic variety, strange South American sloths, and even the huge American elephants, the mammoths. Their characteristic hunting tool, a grooved, exquisitely fashioned "point," superior in workmanship to any other variety of point known from the New World, speaks eloquently of their artistry and skill. But, so far, there is little else except these peculiarly shaped, beautifully made "Folsom" points to speak for the intrepid hunters who made them. Tantalizingly, his unmistakable weapon, but not Folsom Man himself, appears in site after site associated with the now-extinct animals which he hunted.

Although geology has brought corroborative evidence to bear on the antiquity of Folsom Man, it is paleontology, the study of fossil animals, that has so far offered the most revealing clues. There is no longer any doubt that the association of the Folsom point with the bones of extinct animals is real and not accidental. The first discovery, in 1927 at Folsom, New Mexico, of peculiarly shaped implements of human manufacture associated with the bones of a species of bison supposedly extinct since the closing period of the Ice Age, has since been duplicated in other regions by scientists whose investigations were conducted under conditions imposing the strictest control. But the question of the exact age of the Folsom culture is still a controversial subject *revolving largely around the question of when these large Ice Age animals actually disappeared.*

Most of the geologists and students of fossil animal life who have attempted to aid in dating the remains take the view that the last of these animals perished in the closing period of the last glacial retreat some 15,000 to 25,000 years ago. Some, however,

Typical Folsom point

express the belief that many of these archaic beasts lingered down into a period perhaps as late as 5000 B.C.

The animal most commonly hunted by Folsom Man, and hence most commonly used for dating purposes, seems to have been a species of buffalo slightly larger than the existing species and somewhat more powerfully horned. It is commonly termed *Bison taylori* by scientists, in contrast to the term *Bison bison* applied to the living form. Beyond size distinctions the animal's skeleton is not markedly distinct from the living bison which, as a matter of fact, may be its direct descendant. At all events, *Bison bison,* the living form, seems clearly to succeed the older Ice Age bison, probably at the termination of the last glacial withdrawal. The larger form was doubtless adapted to enduring greater extremes of cold, and may have failed to hold its range as the post-glacial climate began to swing toward a warmth maximum to which the animal was ill adapted. Instead, a new and smaller bison, perhaps developed from the bigger species in more southern areas, flows in over its receding range. Whatever the cause, *Bison taylori* vanishes from the High Plains and the historic (living) buffalo succeeds him.

Whether the larger animal followed the ice back northward and lingered there beyond its survival in the United States is a problem which has received little consideration. No data have been available, and both paleontologists and archeologists have concentrated their attention upon the problems of the more immediate area. Hidden away in old books, however, discussed by naturalists interested only in existing animals, a curious broken thread of clues winds backward into the days of the first voyageurs who explored the Great Northwest. If these clues are comprehended in relation to the archeological picture which we have just discussed, they take on a strange and almost startling significance.

As the first explorers and hunters drifted into the region around Great Slave Lake and wandered through the valley of the McKenzie River, they found bison to be present in large numbers, even in this far northern area. As acquaintance with these animals was extended, hunters began to comment that these northern buffalo were larger and differed somewhat in habits and appearance from their southern relatives of the Great Plains. Though difficult of access and hence viewed by few scholars, these distinctions were eventually accepted as valid and the big northern bison came to be regarded as a more rugged variety of the southern animal.

Eventually, in 1897, a naturalist named Samuel Rhoads undertook to describe the type and establish its scientific validity by giving it a varietal name. As a consequence, the animal has since been known as *Bison bison athabascae.* Unfortunately, most of the measurements which exist are hunters' measurements upon the body and are of little value in making comparisons with the skulls of extinct

animals found in the form of fossils.

Rhoads published a few figures, however, and the writer has had access to a few others. These figures tend to bear out a very interesting point which even Rhoads saw fit to hint at in a tentative way: namely, that these big northern bison in certain measurements fell within the size range generally regarded in the United States as representing only the fossil forms of the closing Ice Age. Though, as one might expect, there are contradictions and discrepancies in the various accounts, the earlier literature, in particular, is emphatic upon the subject of large size and greater length of horn. The measurements across the forehead from the base of one horn core to the other are much greater than in the southern bison and as large as in the fossil forms found associated with man.

At this point a question must inevitably occur to the reader. These northern bison, whether or not we attempt to relate them to the fossil bison found associated with early man in the Plains region, are a cold-loving form. Where were they when the ice sheets lay across Canada? Obviously it would seem that their range must have been pushed much farther south. How, then, can we ignore the fact that this big animal may also have been hunted by early man in the High Plains region, or even the suspicion—call it no more than that—that *Bison bison athabascae,* at least in a reduced and mixed fashion, bears some intimate relationship to the big Middlewestern bison of the closing Ice Age? Even if, like some scholars, we merely regard the present northern bison as a climatic phase of the ordinary Plains bison, the question might still arise whether the fossil bison species known as *taylori* could not then be viewed as a similar and even more vigorous reaction to glacial conditions.

Since the surviving northern bison now inhabit a Woods bison preserve in Northern Alberta, it would seem at first glance a very easy matter to settle some of these problematic relationships by a more extended study devoted to detailed comparisons of the skeleton of this bison with that of the fossil forms hunted by the Folsom people. Here again, however, the problem is much more complicated than it appears.

The number of Woods bison declined greatly during the 19th Century and at one time was estimated to be as low as 50 head. In 1893 the Canadian government passed the first laws attempting to protect them. A slight upswing in numbers took place. Then, in 1925, the Canadian government carried out a policy which the American Society of Mammalogists vigorously but fruitlessly protested. Large shipments of Plains bison were introduced into Woods Buffalo Park and a large-scale intermingling of the two types took place. Clearly it is now impossible to be sure of the strain represented by an individual bison. The number of unmixed animals must now constitute a very minute, if existing, fraction of the herd.

Skulls of *Bison bison* and *Bison taylori,* showing comparative sizes of skulls. Drawings by the author, from specimens in Nebraska State Museum

In drawing attention to the tantalizing similarities between descriptions of the fossil species and that of *athabascae,* the existing northern form, it must be remembered that no really thorough comparison is possible in the present state of our knowledge. Nevertheless, the implications of similar body size make it impossible to ignore the fact that the northern bison, at least as it existed in early historic time, may have actually represented a type somewhat more archaic than the Plains bison. If, as seems likely, the fossil bison pursued by the post-glacial hunters of the Middlewestern United States was a form adapted to colder winters, it may have lingered for a time in the Canadian areas, perhaps being slowly bred out as a pure type. If the animal survived in this form, it is unlikely, in spite of its temporary isolation during the 19th Century, and its preference for a forest habitat, that it escaped contact with its southern relative during the days of the great herds.

Evidence is not lacking that a gradual increase in horn size and ruggedness extended from the south to the north in geographic sequence. Such a sequence may suggest that the transition from the fossil to the living form was progressive in both area and time. Only the onset of post-glacial warmth would seem to suggest an adequate causative factor.

In the light of the evidence we have here summarized it would seem that a reasonable possibility exists that this inadequately known phase of the living bison represents, at least in a mixed and dying way, the blood strain of the cold-loving bisons of the late Ice Age.

Whether or not this interpretation is correct, the southward extension of the range of this species during the last ice advance cannot be ignored as a possible confusing element in the study of bison remains from archeological sites where complete skulls are missing. In the size of leg bones the living *Bison bison athabascae* could not be distinguished from the fossil form. Inadequate study of both animals, as well as a dearth of fossil evidence from the Canadian areas, has shrouded in mystery both the disappearance of the fossil species and the appearance of its successor, the existing Plains bison.

Where the big northern woodland bison belongs in this succession of forms can be revealed only by much more thorough research than has as yet been attempted. In so far as evidence exists, however, it is not adverse to the view that these bison may represent an archaic form existing only as a marginal remnant, now fast disappearing.

Nevertheless, even if we could prove that the northern bison bore a very close relationship to the fossil type, we could not, on that basis alone, argue that man's occupation of the Great Plains was extremely recent. Only the last great ice withdrawal seems adequately to explain the change in the type of bison in the western United States.

Undoubtedly the relationship between the big woodland bison and the fossil species hunted by Folsom Man demands clarification. When this is successfully accomplished, we may be much farther along the road toward dating those mysterious forerunners of the American Indian in the Great Plains.

Official U. S. Navy Photograph

The destroyer *Shaw*, in Pearl Harbor on December 7, 1941, shortly after Japanese aerial bombs made direct hits. A false bow got her back to a West Coast yard

Broken Ships Made New

Fast Work by Civilian Engineers is Getting Allied Warships Back Into Service in Record Time

DAVID O. WOODBURY

It is no secret that American warships are taking a battering by the enemy and that some of them are limping home from the battlegrounds of the seven seas, ripped and broken and urgently in need of repair. Half ships, backs of ships, fragments of ships sometimes—destroyers with their bows blown off, submarines torn asunder as if a giant can opener had done the job; corvettes with whole broadsides open to the waves, cruisers with masts down and decks tangled with steel.

In the early part of the war it was German psychological strategy to claim a ship sunk as soon as it was hit. For a while after Pearl Harbor the Jap used the same ruse. But neither enemy does so now. Too many Allied ships have been knocked to pieces only to reappear again better than new, actually stronger in armament and up to the minute in every essential detail. The Axis has learned to fear the vessels it has crippled but not destroyed. The enforced rest period for repair gives our navies a chance to catch up on the latest wrinkles of battle-tested equipment and to send their ships back to sea more formidable than ever.

The secret of this work of renovation — most of it accomplished in American navy yards—is the lightning speed our technicians have developed in making repairs, speed and ingenuity born strictly of the emergency. Feats of reconstruction are being done today which even a year ago would have been called impossible. Before Pearl Harbor a sunken hulk like the bombed destroyed *Shaw* would have been left to rust at the bottom of the bay. But after the Japanese betrayal a new spirit of "can-do" hoisted the *Shaw* out of her grave, fastened a false bow on her, and sent her 2000 miles to a West Coast navy yard for permanent repairs. Now she is back in the fighting line, a deadlier ship than when she was first built. The whole job took three months. A similar rebirth awaits the cruiser *Marblehead,* whose blasted hulk was sailed half way around the world from the Battle of Java to an American port. In ordinary times such an effort would have been absurd; today it is part of the routine of the new warfare.

The credit for performing these miracles of rejuvenation goes to a group of young engineers in our navy yards who have developed methods of their own, not out of books or conventional practice, but out of their own heads. These surgeons in steel are not of the Navy at all, but are men who have joined the show since the war began. A few months ago they were landlubbers with little knowledge of ships and a merciful ignorance of official red tape. The steadily increasing number of damaged ships limping home appealed to their imagination and they asked to be taken into the Naval Reserve so that they might exercise their special talents while the regular Navy men went to sea. Gladly their request was granted; the Navy was not dismayed by the fact that they had no formal training in marine construction. It simply told them to go ahead and do the best they could. Today they are the world's foremost experts in sending broken ships back to sea.

Officially this gang of young bloods is known by the prosaic title of Navy Yard Hull Superintendents. But in fact they are gamblers who play the last ounce of mechanical ingenuity against time. Operating on their own responsibility in what amounts to an administrational vacuum, they turn out seven-week jobs in three weeks, five-day repairs in a single night, and seemingly achieve the impossible with every problem they undertake. They are little known outside the yard gates and they receive no medals. But they are patriots none the less. Voluntarily they have sacrificed good civilian salaries, given up their private lives, thrown away their holidays and spare time, all because they have discovered a vital way to help win the war. They are young, angry America stepping up front to fight.

How they work is typified by the example of a young lieutenant who may be called McCantry, on repair duty in an Atlantic Coast yard. Not long ago a battered warship was on her way in from sea, her "availability" for overhaul only eight days. This ship had been on action station for months—some 40,000 miles of sea duty without a break. Officers and crew were weary from weeks of confinement in her battleshaken interior. To get

back to work their vessel must be renovated from stem to stern—in eight days. They were angry particularly because they knew that this could not be done.

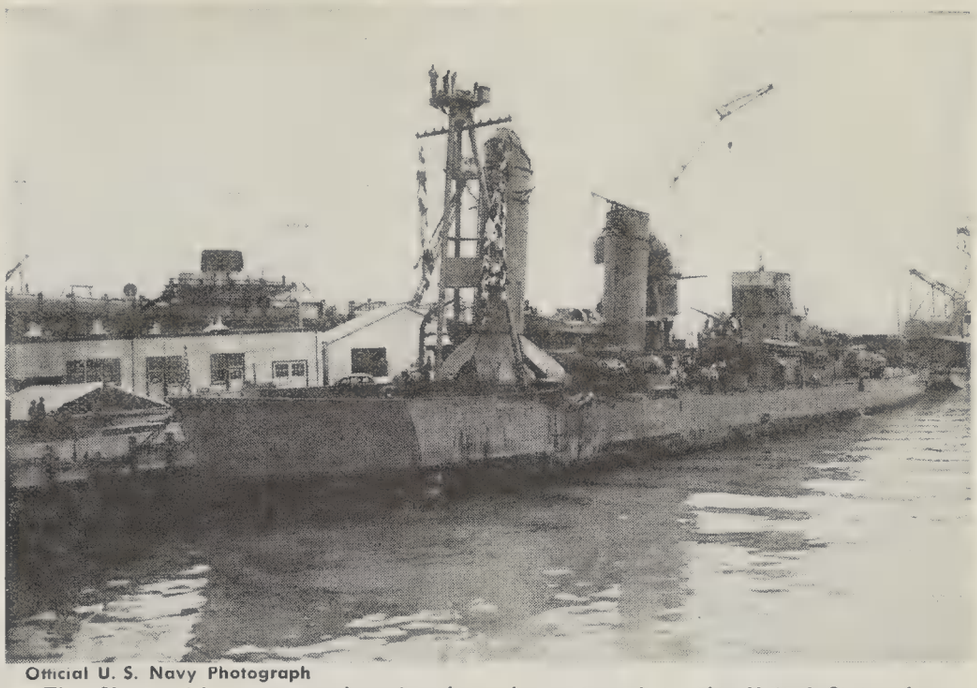
Commander Gurney, the Boss Hull Superintendent of the yard, was the first to hear of her coming by radio. He took a quick look at the work board in his office and summoned McCantry. "Do what you can, young fellow," he ordered. "Put her in Dock Four and turn the yard loose on her. I'll inform your wife you won't be home."

Mac grinned; this was a challenge such as he loved to meet. Pulling the telephone to him he began rounding up his forces. All over the yard shop bosses and estimators threw on their coats and converged on a Navy tug at the pier. Within ten minutes McCantry and his men were on their way down the harbor to meet their ship. Their timing was perfect. Within half an hour they had scrambled aboard the tired warship and were on their way back to the yard. During the trip they had just 30 minutes to complete their inspection and lay their plans.

Skilfully Mac surveyed the damaged ship. There was certainly plenty to do. Hull plates sprung on the port side, super-structure cluttered with wreckage from a direct bomb hit, mast out of line, small boats smashed, gear of all kinds gone adrift. In the wardroom, however, he made no comment, only asked for details. The Executive Officer threw a list on the table. It was ludicrous in its length. New A-A guns, new cranes for the boats, new magazines and fire control; hull plates removed and straightened, mast reset. Acid lockers and fuel tanks cleaned and relined, radio equipment replaced, crew's quarters remodeled, windlasses, anchor gear and steering equipment overhauled. Ventilating system, boat cradles — everything — pulled down and refitted. From fighting tops to keel plates the ravages of uninterrupted battle service had to be erased. And at the bottom of the list was this: Complete overhaul and repair of potato-peeling machine.

THE Executive Officer grinned wryly. "Here you are, Lieutenant. Do whatever you can in a week."

Most of those jobs were major operations—a month's work at least, by pre-war standards. But McCantry had learned to work differently. Snatching a pad and pencil he began to break down the list and pass the sheets to his various yard bosses amid a cross-fire of discussion and orders. There was no time for formal blueprints or routine procedure. Every foreman must carry his part of the work in his head or scratched on the back of an old envelope. After this one conference there would be no further powwows. If difficulties arose they would have to be solved empirically, on the spot.



Official U. S. Navy Photograph

The *Shaw*, with temporary bow in place, has returned to the United States for final repairs and the installation of a new bow. She is now deadlier than ever

When the Navy Yard was reached Mac's plan of campaign was complete.

In the hour and a half required to drydock the ship the young hull superintendent rounded up his supplies and set the various shops in motion. The dock was not yet dry when a thousand men, drawn from every department, began swarming aboard with their tools. Power lines were going up, portable machines were swinging aboard from overhead cranes; stagings were being lowered over the ship's sides. While the sailors scurried ashore to be out of the way, workmen were penetrating into every compartment, each charged with a specific job.

Already familiar with the ship's layout from stem to stern, McCantry established a route of inspection and began circulating methodically, showing each riveter and welder, carpenter and linoleum layer how to work without interfering with his neighbor; keeping up the tempo with a cheery word or a bit of advice or praise. The important thing in an emergency like this was to set the pace and maintain it. It was a battle against time: The men all knew their jobs; all they needed was the example of a boss ready to sacrifice himself to the limit to accomplish the work. So, through the first day and night and the second day Mac remained aboard continuously, without sleep, carrying a sandwich in his hand and a bottle of pop in his pocket. By the second night things were proceeding so well that he kept on until the unrelieved stretch had lengthened to 66 hours. Only then was he so sure of success that he could throw himself down on his office desk to snatch a few hours of badly needed sleep.

IT was McCantry's hunger for punishment and his calm assumption that every man under him could take it as well as he could himself that put this job through. At the end of six days and nights, with all hands working 16-hour shifts, the ship was completely repaired and renovated. Every item in the list was checked off and done, even to the overhauling of the potato-peeling machine. On the seventh day the vessel was ready for sea, better than new.

The secret of wartime repair lies in the democratic system of free enterprise and individual responsibility. Each new job is pushed through to success in record time because it is a complete campaign in itself, under the guidance of a man who is in an individual race against the enemy. When the need for high-speed repair first hit the yards no one knew how to meet it. The hull superintendents were kindergarteners then and the Navy did not expect very much of them. But it had no choice but to turn these reserve technicians loose and let them try. What these Commandos of the shipyards did with the opportunity has set a new American standard for high-pressure work which has been copied in every shipbuilding yard in the country.

McCantry and his companions cut their eye teeth on the Allied warships that limped into our yards in 1940 and '41. These foreign casualties were especially tough, for they had been through the combined infernos of Crete and the Western Approaches, surviving attacks by torpedo, naval gun, and aerial bomb. Some of them were almost total wrecks—floating junkyards that even their owners despaired of saving. Moreover, they were built in a different style from our own. Thousands of small fittings—valves, bolts, pipes, and machines—were of slightly different design and could not be replaced out of American stock. Many a repair part had to be made up specially for the job, often by hand in a machine shop or foundry. From the start this kind of work taught the young technicians to improvise, taking whatever they had on hand and making it fit. When standard steel plates were not wide enough, they patched smaller ones together by welding. When American electric lamps didn't fit foreign sockets, they ripped out whole wiring systems and put them in new.

Every visiting ship carried a full set of plans by which repairs were supposed to be possible — in their home yards. But many of the specifications couldn't be met in America. So the hull superintendents sometimes had to ignore the plans altogether, inventing new layouts and construction details as they went along. Thus they made a virtue of necessity and soon had developed the habit of solving their problems out of their heads, leaving standard practice behind. They knew the results required; how these were achieved mattered little so long as the job was done quickly and with success. It was an engineer's paradise. With the huge resources of the yards at their backs they could build new ships out of old ones with no other limit than their own ingenuity and endurance. The old complaint that "it can't be done" had become for them a challenge and later a guarantee of success.

Our allies, desperate for ships, were incredulous. When a great dreadnought came in for repairs the British feared that the job would take a year. Her wounds, though not publicized, were extremely serious. At the end of 70 days she sailed again, a new battleship with many improvements suggested by the loss of the *Graf Spee*. The British were delighted. As many as possible of her naval casualties are now sailed to American yards for repair.

The heavier the steel of a warship's hull, the tougher the problem of cleaning her up after bombs and torpedoes have torn her apart. A typical case of heavy repair confronted a sandy-haired young ensign named Mullins, who had graduated from engineering school less than two years before joining the Reserve. He had to get this ship into drydock without permitting her ragged bottom plates to smash up the dock flooring on the way in. Coolly he had her crew make the ship fast to a pier in deep water. Jumping into a diving suit he went down with a couple of professional divers with underwater cutting torches. The three of them spent all day and part of the night cutting loose jagged pieces of steel, constantly in danger of having their life lines cut by the knife-sharp edges all around them. Mullins had never been down before; without practice he shouldn't have gone. But he wanted to save time by applying his knowledge of cutting methods directly to the job in hand. As a result the ship was drydocked a full half day ahead of schedule and repairs beat every previous record set by the yard. Mullins's example in that first risky operation had put every workman on his mettle.

Official U. S. Navy Photograph

The *Shaw*, in drydock on the West Coast, with her new forward section shown in the foreground ready for installation

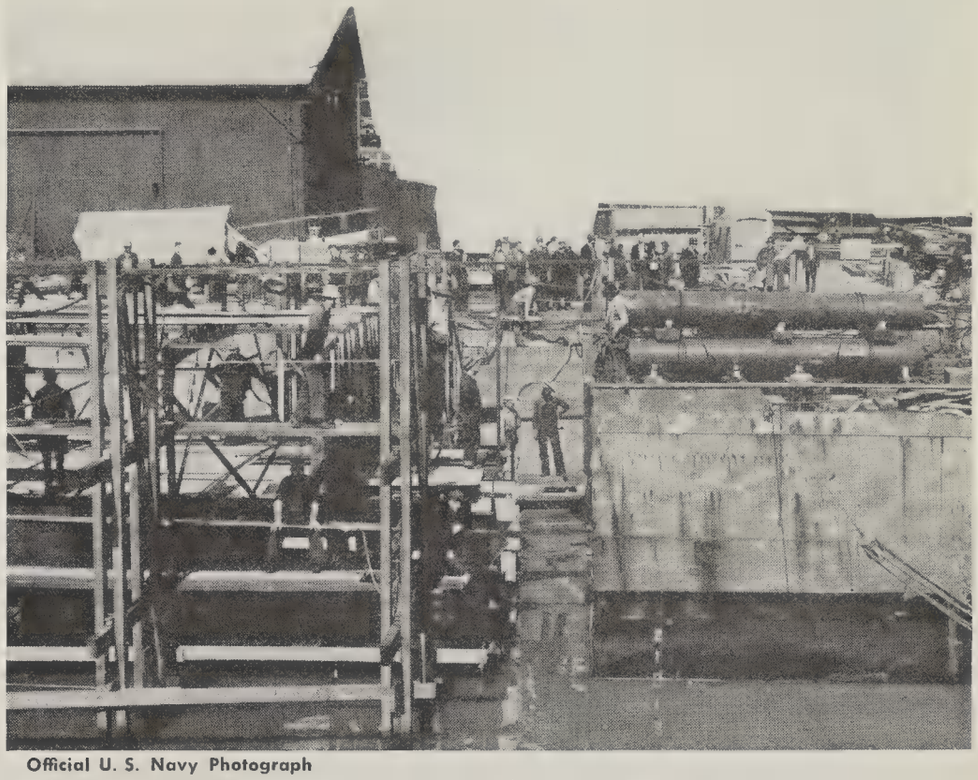
These young hull superintendents wear the uniforms of Reserve officers of minor rank—indistinguishable from thousands of others who do our naval fighting and patrol. But their authority is out of all proportion to their stations; it is unique. To be in charge of a whole warship under repair is to be the boss of every civilian on the job and to have priority to get things done immediately in all the shops. It means that the young engineer must know every compartment on the ship, understand the purpose of every beam and plate and every machine, and know how to find any kind of trouble and set it right. In addition, he must handle his men skilfully and get along with every yard boss into the bargain.

He is working on his own, with millions of dollars worth of ship at his mercy. Actually he is tied solidly into the navy yard organization in a position that is simply streamlined to fit the emergency. In each of the yards he and his colleagues report to a Chief Hull Superintendent—a naval old-timer who parcels out the work and keeps a seasoned eye on his little group of virtuosos. The Chief in his turn is responsible to the yard's Construction Officer, who is directly answerable to the Commandant. None of these three head men tolerates red tape. In this repair job there is something of the spirit of the research laboratory, where independence and initiative are 90 percent of the stock in trade. Only one requirement is held over the men: they must get their work done right, in record time. How they do it is their own affair. They must work out their own contacts with departments of

supply and manufacture and transportation. Nobody interferes with them unless by their failures they prove themselves unequal to the job.

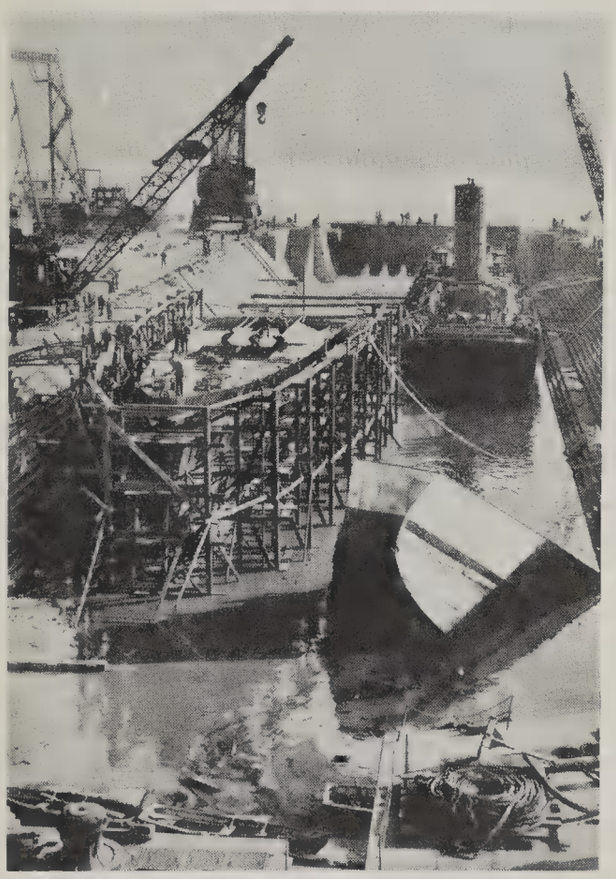
In peacetime such tremendous responsibility on young shoulders would be impossible. But results have proved repeatedly that lifelong experience is not necessary. Ingenuity and plain common sense get the hull superintendents out of every jam. When they come to the yard they do not enter any long course of training, but are given a repair job and told to go ahead. If they make mistakes they must rectify them as best they can. The Navy knows that these fellows have been used to independence. Their great contribution will be innate judgment and the energy of youth. The Navy has learned that when a man has no time to make mistakes he won't make them.

The hull superintendents are drawn from all over the land—from industry, business, laboratories, sometimes from college graduating classes. Admiral Yarnell, of China fame, is credited with the idea of digging them out and giving them a try. When the repair problem threatened to become serious he persuaded the Navy Department that industry was full of young engineers who would make top-notch fixers of damaged ships. He made a tour of the technical colleges and large corporations and interviewed hundreds of men from 25 to 30 who had shown outstanding ability along engineering lines. He told them there was a big job to do in the yards; that, although he could offer them little money and no fame, they would have an unbeatable opportunity to serve their country by doing the work they knew how to do best. If they would come he would see to it that red tape was cut and that the sky was made the limit for results. They took him at his word and joined the Reserve in droves.



Official U. S. Navy Photograph

A close-up of the operation of joining the *Shaw* to her new bow. The ship, at right, is being floated into position for attaching the bow which is seen at the left



Official U. S. Navy Photograph

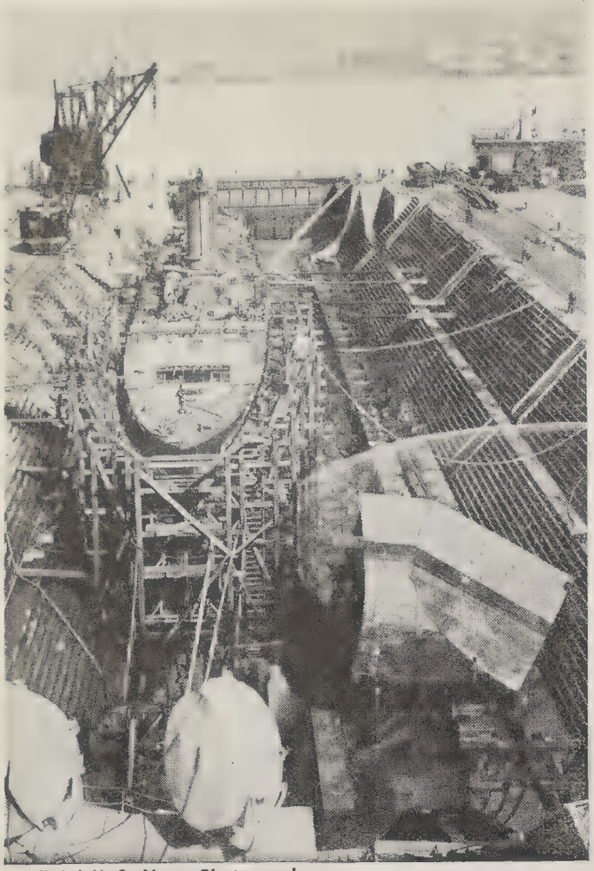
The *Shaw's* temporary bow has been removed; ship (in background) will be floated to new bow

McCantry, for example, was a welding specialist for a large manufacturing outfit. Mullins worked for a farm machinery concern. Young Johnson had been a naval architect with the Maritime Commission. Teale had a small consulting firm of his own. These men and many more like them had been uneasy in their civilian jobs for some time. They wanted to get into the game but saw no way of making their special talents useful. Then came Yarnell's offer and inside of a month they were repairing ships.

Men like Martin and Baker, cement plant engineers, had been responsible for many short-cuts and improvements in their own line. Both thought they had something to give the Navy and both joined up. Martin had once been a football man and Baker was a tennis star; both knew the value of quick independent decisions and at the same time understood team play. In their Nebraska home town they were told they were crazy to go to sea, but neither listened. They went to West Coast yards and began.

BAKER specialized in destroyer repairs and eventually sailed with a gang of mechanics to Pearl Harbor just in time for the Jap onslaught. When the *Shaw* made her place in the news by rising from her grave and making the run back to the States under her own steam, the Japanese were puzzled, for they had seen the ship's magazine explode, ripping 50 feet of bow clean out of her. The mystery was easily explained. Ensign Baker had asked permission to try an improvised salvaging operation. Getting it, he had hauled the wreck into drydock, cut away several hundred tons of mashed plates and beams and then calmly welded a mud-scow bow over the *Shaw's* wide-open end. It was not a new trick but the time record for such a job had never been approached before. And time was now more valuable than gold.

There are other men like Baker,



Official U. S. Navy Photograph

Once more a whole vessel, the *Shaw* is a monument to the spirit that will eventually emerge victorious

working at Pearl Harbor on jobs that can't be described. Regular Navy and Reserve are on duty there together, and the hull superintendents are hanging up records as good as or better than the *Shaw's*.

These Reservists are successful largely because so much is expected of them. One fellow named Smith, in an East Coast yard, makes a specialty of long hours. Twice recently he has gone for 36 hours without sleep when small patrol boats had to be repaired in a hurry to get back to the Atlantic submarine hunt. Smith gets home on an average of once a month and then only for a few hours. He has a cot set up in his tiny office and lives largely on sandwiches and coffee handed him by the crews of the vessels he repairs.

ANOTHER hull man named Telford prefers trick jobs, the less routine the better. The Boss Superintendent knows this and gives him every mechanical impossibility that comes along. Telford's high-water mark was a vessel with a smashed mast and a lot of topside damage that had to be sent to sea in three days. It was 24-hour work all the way through. He had to make and install a new mast, which he did in the rigging shop complete. It was ready to set on the last night, 12 hours before sailing time. Telford decided to set it himself. And so, about midnight—moonless, pitch dark, the wind whistling through his baba coat—he climbed aboard the spar and rode into the sky at the end of a wire rope sling suspended from a hammerhead crane far overhead. Then for three hours he jockeyed the mast up and down, easing it into place in the ship by signalling the crane operator above him with a flashlight.

It was a grim job but Telford himself was not grim; he was almost blythe. All through the night he swung in the air, singing, and his song carried through till dawn. And though Telford was pretty well frozen, pride sent him below to try a piece of thin paper between mast butt and seat when the job of lowering was done. No mast had ever fitted before on the first try but this one did. Lieutenant Telford had made the measurements for it himself and was not in error by a thousandth part of an inch.

Gleeful victories like this go on day and night in every yard. Word came to one hull superintendent named Deane that half a dozen "PT-boats" were urgently needed "somewhere south." Deane revolved the problem in his mind and quickly eliminated all the orthodox solutions. The PT's were too small to make the long trip by themselves and too big to be shipped by rail. So he decided to load them aboard a converted merchantman scheduled to leave the yard next morning.

Grabbing a ruler he went aboard to make measurements. As he expected, the 'tween-deck space was too low for stowing the boats and nothing could be done to improve it. The only way out was to dismantle the boats and send them south in pieces. Calling in the boat manufacturer to give him help, Deane quickly stripped them of everything—guns, torpedo tubes, masts, pilot houses, and all. Plywood bulkheads were ripped out by main force. He knew that others like himself could put the little craft together again on arrival.

In the middle of the night—as usual—he was ready; the PT's had been trimmed down to fit. Taking a boss rigger up on the ship's fo'c'stle he established communication by flashlight with the crane operator 160 feet above and the PT's began to swing through the air toward the cargo hatch. As the first one inched down Deane realized that the hatchway wasn't quite long enough to let her through. At any other time the whole plan would have been scrapped as impossible. Figuring rapidly, Deane decided to drop the boats slantwise, nosing them through the hatch and hitching their sterns in last. It was a delicate operation in the dark but it worked, with a trifle less than one inch to spare. The whole flotilla was snugged down in the hold by morning without scratched paint on any one.

THE spirit that sent the pioneers across the Plains and drove back the frontiers of science in the laboratories is sustaining these youngsters through their long night vigils and daily grinds. What keeps their courage up is their perpetual interest in something new. Every repair problem is a fresh challenge, prefaced by the near conviction that it can't be done. What the Navy has done is to let loose the native American love for invention. These hull superintendents are never held down by routine. Their energy is never sapped by long waits while red tape unwinds. Nor is it falsely buoyed by hope of recognition or financial reward. They will never get medals or newspaper headlines. But they will get something else that means more to them than all of these—the certain knowledge that without them many a ship would never again meet the enemy.

For the millions who must remain in civilian life this vital achievement of the Naval Reserve is a heartening thing indeed. It proves how strong are the sinews that lie dormant in a nation whose enemies once crowed that it was too soft and too slow. For the McCantrys and the Mullinses, the Deanes and Telfords, the Bakers and Smiths are no different from ourselves and each of us will be capable, when the time comes, of turning in as good a performance as theirs.

●

¶ *THE foregoing article tells the story of only one of the many groups of unsung heroes who, just as much as the soldier, the sailor, and the marine, are doing more than their share toward winning the war. The stories of others of these groups are being ferretted out, and it is hoped that, censorship permitting, more than one of them will be published in the pages of this magazine.*—The Editor.

Contact Lenses

With Recent Advances in Technique, These Aids to Vision Have Become Much More Satisfactory

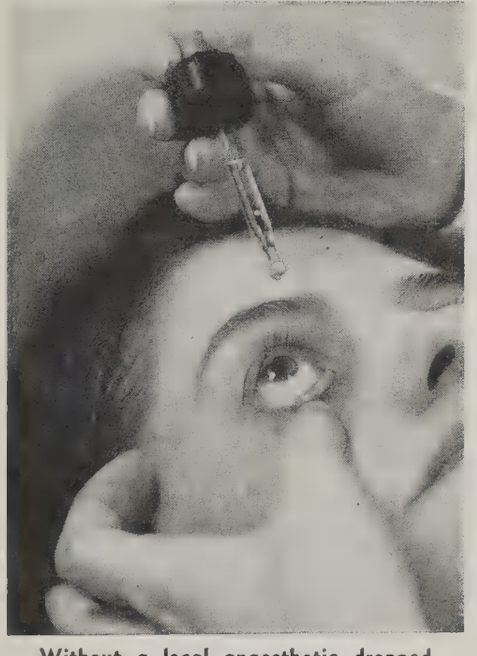
ALSTON CALLAHAN, M.D.
Atlanta, Georgia

"INVISIBLE glasses? Contact lenses? You mean the kind that you put underneath your lids right against the eyeball? Ugh! I don't think I could stand them. Are they safe? And aren't they frightfully expensive?"

Many react in such a manner when the subject is mentioned, and it is true that the aversion to putting something into the eye is natural. But here are the facts.

It is only in the past few years, since clear plastics were devised, that the safety of contact lenses has been entirely beyond dispute. Also, it is only in the past few years that their construction has been scientifically accurate. Today, there are between 3000 and 5000 wearers of contact lenses.

Until recent years contact lenses were made only in certain sizes. This required an exhaustive sitting while the user's size was selected, necessitating insertion and removal of dozens of lenses in the attempt to find one having the correct fit. The contribution which has now made contact lenses far more usable was made by T. E. Obrig, a New York optician, who pioneered in making molds of the individual's eye, entirely of plastic material, so that the fit was as precise and individual as a fingerprint. Obrig's investigation of contact lenses showed that the size of the cornea varied so much in different persons that it would be next to impossible to fit them really accurately from stock sizes. Therefore, each lens must be tailor made. Exactly how this is done is shown in the accompanying series of illustrations.



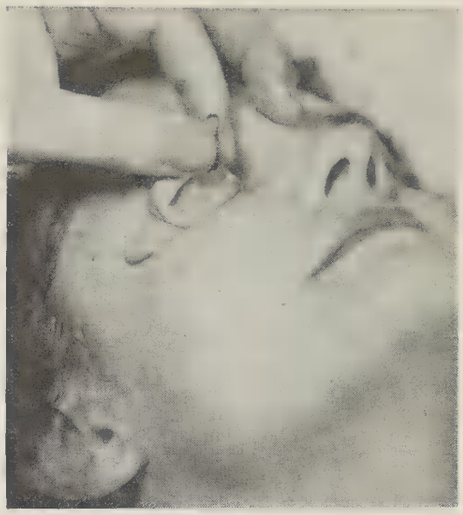
Without a local anaesthetic dropped into the eye it would be a difficult, painful procedure to take a cast of it

The warm wax for making the mold is poured into a little glass casting shell, ready to invert quickly over the eye, as in the picture above

First, a local anaesthetic is dropped into the eye, so that no pain will be felt during the casting.

Next, Negocoll, a hydro-colloidal plastic composition somewhat midway between a wax and a jelly, and which is liquid when warm but solid when cool, is heated to 118 degrees, Fahrenheit, and allowed to cool to 107 degrees. It is then poured into a small casting shell, and the shell is quickly inverted and gently pressed against the front of the eye as the lids are pulled out of the way.

The Negocoll cools in a few minutes to normal body temperature and solidifies, whereupon the mold may be removed from the eye.



The casting shell is pressed against the eye. In the photograph the upper eyelid is over the shell. Some of the jelly-wax trickles down the cheek

The casting shell, bearing in the wax the perfect imprint of the eye, is then placed in some convenient holder, and freshly mixed dental stone, ordinarily used for making casts of teeth for plates, is poured into it.

This substance hardens to form the cast. The fifth picture shows two typical castings. The one held in the hand shows only the reverse side, on which identifying marks are scratched, but the separate one shows an exact duplicate of the front surface of an eye. So accurate are these castings that impressions of small blood vessels can be traced.

IT is from these castings that the contact lenses of clear plastic are made to fit the eye.

The final photograph shows a pair of finished contact lenses. It will be noticed that the central position of each lens bulges out slightly. This central position does not come into contact with the central, transparent part, or cornea, of the eye at all. The outer, flanged part, rests only on the white part of the eye where it causes no pain or disturbance.

The "power," or strength, is ground on the non-contacting central portion of the lens, which will be in front of the cornea.

When the lenses are worn, the space between the central position and the cornea of the eye is filled with a special buffer solution, dropped into the hollow of the lens before it is inserted into the eye. Wearers—even highly nervous persons—learn quickly how to insert and remove contact lenses, the initial hesitancy soon giving way to a routine, as with a dental plate.

After the first fitting, contact lenses are worn for an hour or so. This period of time is gradually extended as tolerance is developed, until they

From the cast just made, which might be called a negative, a positive cast, duplicating the eye, must now in turn be made. Casting shell lies on table

are used continuously six, or eight, or even 12 hours. It is best to remove them every night and re-insert them every morning, but one young man, who did not read the instructions carefully, left his lenses in for two weeks without doing any harm to his eyes.

DESPITE all precautions taken in making the mold, it occasionally happens that the lens will touch a position of the cornea, which eventually would cause damage. Formerly, exhaustive studies with the microscope were necessary in order to rule this out. Here came another of Obrig's outstanding contributions—the use of fluorescein. When invisible ultra-violet rays are thrown on fluorescein, it glows brightly in the dark, and has thus been made use of in producing spectacular effects in the theater. Obrig filled the space between the lens and the eye with fluorescein and turned on the ultra-violet radiation. If the contact lenses fitted perfectly, the entire central area glowed. If the lens touched the cornea in any area, however small, that area remained black, for the fluorescein was displaced. By grinding off a minute amount of the lens, and then retesting with fluorescein, it is possible to continue the adjustment until the fit is exact.

The "physical fit," or the actual fitting of the lens, can therefore be achieved to perfection, while the "optical fit," or the grinding on the lens of the correct strength, whether it be for cone-shaped cornea, astigmatism, near-sightedness, or far-sightedness has been done accurately for some time.

Chief among the few minor problems yet to be completely solved is the matter of the "chemical fit," for a few eyes have difficulty in using a standard buffer solution worn regularly between the lens and the cornea. But recent investigation in the shifting of the acid-alkali balance has pointed out a new approach to this, and it is likely that the small fraction of people who cannot be "chemically" fitted will be even further reduced. Though the use of this fluid complicates to a slight degree their insertion, doctors who prescribe contact lenses point out that it is because of this

An exact cast of each eye. The one in the hand shows the back on which identifying marks are scratched. The other, lying on the table, is a front

From the molds just made, the final contact lenses are cast in plastic and finished, each as individual as a fingerprint, are each a precise fit

that these lenses, once fitted correctly, may last easily ten years or longer. For the ordinary factors which render necessary the changing of ordinary glasses every year or so, because of altering astigmatism and so on, are entirely neutralized by the "fluid lens" which naturally fills whatever irregular space is present. And thus their cost, when the period of service is considered, is not so great.

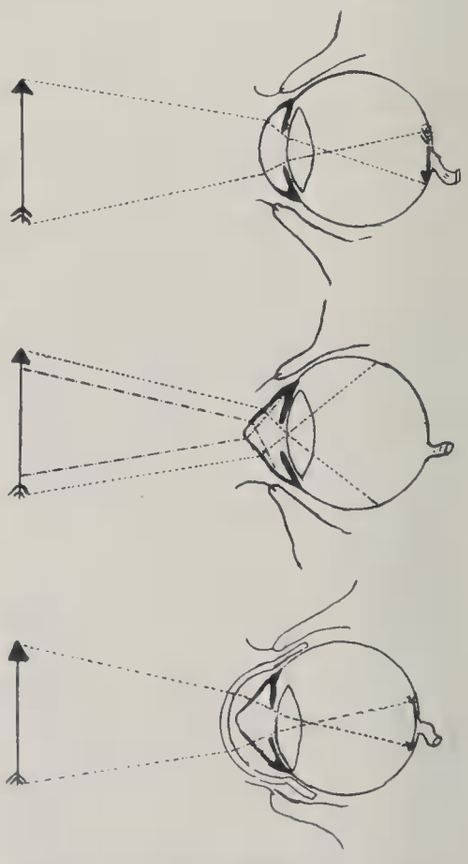
Fitted contact lenses are still quite expensive, as each pair is as individual as fingerprints. Melted down, you could buy the plastic used for only a few cents; but so highly technical is their fitting, to say nothing of the skill required of the manufacturer, that it is unlikely that they will soon be cheaper.

Contrary to a widespread belief that contact lenses were designed primarily to satisfy a desire for a more sightly substitute for spectacles, the motive for their development has been to give vision or protection to certain kinds of abnormal eyes which can be benefitted by no other means. One such example, showing how a contact lens gave good vision where there was practically none, is shown in the drawings.

The upper drawing shows a normal eye which attains perfect vision because the cornea and lens focus the rays of light from the object viewed onto the retina, from whence it goes to the brain by way of the optic nerve.

In the middle drawing is a case of keratoconus, or cone-shaped eye. Because of the cone shape, the rays of light are not focused—some do not pass through the pupil and others spread out to the edge of the pupil. All this eye can see is the difference between light and dark, and ordinary glasses will not help.

But the contact lens in the lower drawing affords normal refraction of the light rays again. As is shown, it fits against the white part of the eye, but does not touch the clear part (cornea) where it would cause discomfort. The intervening space is



A normal eye, an abnormal eye (serious case of keratoconus), and the optical effect of contact lenses: restored vision in a "hopeless" case

filled with the special buffer solution regularly worn with the contact lenses. Now, since the refractive index of this fluid is almost the same as that of the fluid within the eye itself, the rays of light focused by the contact lens pass unchanged by the distorted cornea to the retina as happens in the normal eye.

There is a rather widespread belief that contact lenses are a new idea but this is by no means the case. They represent the culmination of years of hard work and investigation by a score of scientific men, most of whom approached the problem from different angles and each of whom made some real contribution to the solution.

The first scientist to propose and record such an idea was the astronomer, Sir John Herschel, who suggested in 1827 that a glass shell could be devised to fit over the eye to protect it from infection by a diseased lid. Sixty years later F. E. Mueller, in Germany, made one of blown glass which successfully protected for several years the eye of a patient who was unable to close it because of cancer of the lid.

In 1888, A. Fick, also of Germany, suggested that contact lenses be used for the condition called keratoconus, or cone-shaped cornea, described above. For this the Zeiss firm made contact lenses of blown glass.

In 1892 Sulzer ground some contact lenses of optical glass. They gave good vision but caused discomfort and could not be successfully worn.

In 1909 the Mueller optical firm produced contact lenses of "glass eye" glass but, among other imperfections, these contained impurities and had a very short life.

In 1920 Carl Zeiss accurately ground and polished contact lenses of chemically resistant glass, but only in one size. By continuing their research they found that varying sizes could be made. Not only could these be used for conical cornea, but also for near-sightedness, far-sightedness, and astigmatism. For the first time, contact lenses were brought within reach of the average person having a more commonly found type of defective vision. Many persons were fitted with these lenses, but to users in the United States it meant not only an exhausting sitting, requiring the insertion of dozens of lenses in the attempt to find one having the right fit, but also a long delay, since the lenses had to be shipped back to Germany one or more times to have the necessary strength ground on the lens.

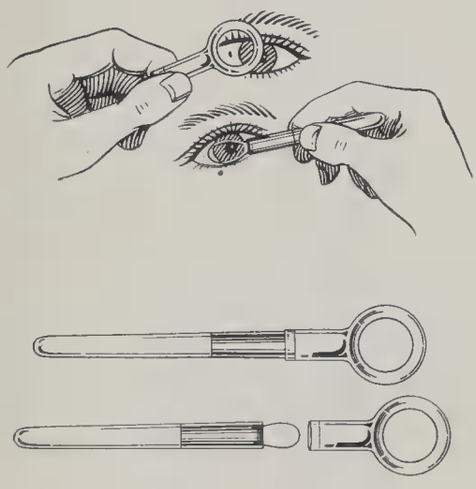
And now we have the new type of all-plastic, individually *fitted* lens, and other refinements. This is where the present story takes over—contact lenses made really wearable.

• • •

PARTICLE REMOVER

Smooth, Magnetized Wire Loop For Foreign Bodies in Eye

A MAGNIFYING glass is often of great assistance in locating foreign bodies in the eye, and such bodies can be conveniently removed by means of a loop of smooth wire. These two aids in particle removal have now been combined in the Mag-Optin unit shown in the accompanying drawings. The magnifying lens is made of a plastic material and is unbreakable. The handle is also of plastic, and the wire loop is affixed to the end of it. The loop itself is magnetized so as to assist in the removal of magnetic particles from the eye. Non-magnetic metallic particles, of course, are mechanically removed by the smooth wire loop.



Magnifies and removes

SACCHARIN

No Harm in Ordinary Use of the Super-Sweet Substance

Now that sugar is rationed, the thoughts of some have turned to saccharin and there are rumors that saccharin is dangerous. While killjoy friends are always ready to tell us that whatever we enjoy is "dangerous," *The Journal of the American Medical Association* is no killjoy about saccharin. It states editorially:

"Sugar rationing and new emphasis on weight reduction have doubtless increased the use of saccharin for sweetening purposes. Renewed interest in the possible harmful effect of this substance is an apparent corollary. Earlier investigations of saccharin, however, have failed to reveal dangerous side-actions except from extremely large doses. Likewise the evidence does not reveal any reason why saccharin cannot be used continuously in average sweetening doses for an indefinite period. Many patients have taken saccharin for years without harmful effect."

IVORY DOME

Baldness May Be Caused by Calcification of the Skull

A NEW theory of the cause of baldness has been proposed in *The Journal of the American Medical Association*, by Dr. Frederick Hoelzel of Chicago. The cranial sutures, or little wavy joint cracks of the skull, also other skull openings, may become calcified and shut off some of the circulation to the scalp. He describes "observations which I made while serving as technician in gross anatomy.

"I then had occasion," he continues, "to remove the brains of about 80 cadavers for separate use in the neurology classes and incidentally noted a seemingly obvious relation between the blood (vessel) supply to the scalp and the quantity of hair. Baldness occurred in persons in whom calcification of the skull bones apparently had not only firmly knitted the cranial sutures but also closed or narrowed various small foramens through which blood vessels pass, most prominently in persons with a luxuriant crop of hair.

"These blood vessels are mainly veins which normally communicate with the diploic veins in the spongy tissue of the skull bones but which are evidently pinched off by calcification of the foramens. Various stages of this process of impairing the blood circulation of the scalp could be observed.

"This, then, not only explains why baldness occurs but also why men are more likely to become bald than women, since bone growth or calcification is generally greater in males than in females.

"Obviously 'hair tonics' or vitamins are not likely to restore a blood circulation through what has practically become 'solid ivory.' Moreover, one wonders whether the promotion of a higher calcium intake among adults may not eventually increase the incidence of baldness and the sales of its vaunted remedies."

Science in the Forest

Modern Forestry Management Takes into Consideration All Phases of Wood Growing and Utilization

G. H. COLLINGWOOD
Chief Forester, American Forest Products Industries, Inc.

MODERN forestry, plus more scientific utilization of wood, are insuring adequate supplies of this vital natural resource for all of America's war needs while maintaining reserves for the future. The fact that wood is as important to military effort as oil, coal, or iron ore makes this especially significant. More than that, the importance of wood is further increased because its principal components, lignin and cellulose, are the basis for increasing numbers of "ersatz" products.

Sugar, textiles, proteins, alcohol, cattle fodder, industrial chemicals, and plastics —as well as an endless number of other derivatives — can be obtained from wood. Nazi war production is backboned by wood. In this country wood contributes to the war effort by providing in whole or in part approximately 1100 items of Army and Navy use. These include ships, cantonments, pontoons, gunstocks, tools, barracks and equipment, explosives, flamethrowers, gas masks, airplanes, packing boxes and crates, paper products, and fabrics.

To supply these needs our forest products industries are being called upon to produce 38 billion board feet of finished lumber this year. In addition, wood is needed for chemical distillation, fuel, and paper pulp. This is tremendous but not disastrous when one bears in mind that timber is a growing crop—a replenishable natural resource.

Fortunately, trees are living organisms whose growth and natural capacity for reproduction may be accelerated by careful management. Trees will die, but a forest may live forever. Many timber owners of the United States, well aware of this, are engaged in a program of conservation and reforestation whose objective is to guarantee abundant supplies of this basic raw material for all time.

This objective can be attained. Much has already been accomplished. Shortly after the turn of the century the then chief forester of the United States uttered a prediction concerning the future of our timber supply which, had it come true, would have proved dire indeed. "We have all but reached the end of these forests," he said. "We have reached the point where the growth of our forests is but one-third of the annual cut, while we have in store timber enough for only 20 or 30 years at our present rate of use." On the basis of such premises, he prophesied an inevitable "timber famine" which would affect every individual.

Because this stand of trees has been thinned, those remaining will increase in growth rate. Note low, economical stumps

After more than 30 years, our annual new growth of timber amounts to over eleven billion cubic feet. This is not board feet, but in addition to fuel-wood, pulpwood, and other products which are adapted to measurement in cubic feet, it includes 32 billion board feet of saw timber. When we entered the war, this new growth, or annual crop, was approaching the point where it would balance the annual amount commercially consumed. Had the war not intervened, the new growth might have equaled or even exceeded the annual forest drain from all causes by 1945.

Commercial harvesting of trees does not account for the entire amount taken from the forests each year. Fire, insects, tree diseases, and decay take constant toll. Ceaseless war must be waged against these fruitless losses as part of the forest industries' program for forest conservation and silviculture.

What may not be generally realized is the fact that timber is a crop just as surely as wheat or corn. Consequently, trees must be protected from fire and such "natural enemies" as insects and fungi. They should be harvested before ripeness turns into rot. There is no better way to provide for new timber crops.

FORTUNATELY, areas naturally suited to forest growth are abundant, and timber stocks are available for our needs. One third of the United States is covered with trees. When the colonists arrived in America, there were some 822 million acres of forests. During the succeeding three centuries those forests have yielded over seven trillion feet of forest products for the building of the country. Despite that use, and excluding the acreage cleared to make room for cities, towns, and farms, we still have 630 million acres of forest. This includes over 460 million acres classed as commercial forest, of which nearly a quarter is virgin timber. The term "virgin" applies to timber so old that it antedates the memory of man so that much of it has long since reached maturity and needs to be harvested to be saved.

America is now, and has been for 20 years, in a period of forest transition. No longer is it necessary to clear land for additional agricultural production. The present forest area of the United States is generally recognized as serving its maximum use if it

continues to grow trees. This realization heralds a new era in which timber is being harvested as a crop, rather than "mined" after the destructive fashion of pioneer days.

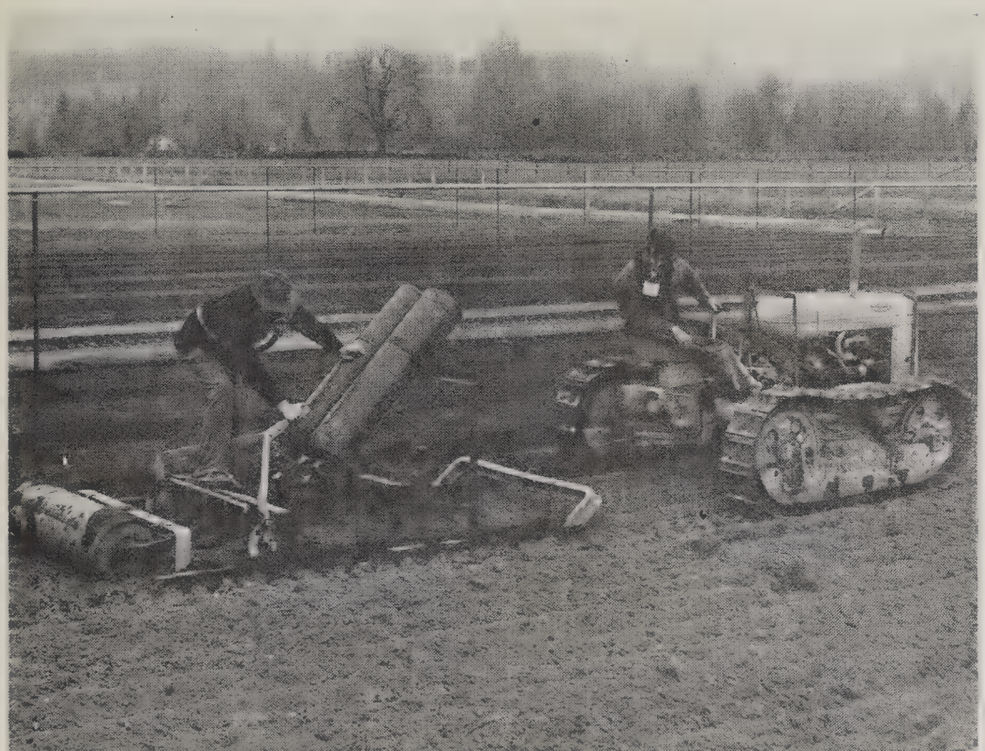
Forestry is based on the established fact that trees are living plants whose reproduction, growth, and development may be encouraged by the application of relatively simple rules. Where possible, forests are harvested in ways to assure recurring crops of new trees. Where clear-cutting is necessary, this can be done by leaving seed-trees. Individual windfirm trees with full crowns may be left at frequent intervals across the cut-over area, or groups of trees, capable of protecting one another while producing seed, may be left along water courses, on ridges, or in strips. Where practicable, selective cutting keeps the forest continually productive, at the same time avoiding abrupt changes. Forestry also calls for effective protection of the growing trees from forest fires, continuous warfare against insect pests and tree diseases, and effective use of as much of the wood as possible.

Baling tree seedlings at a nursery. The forest industries of the Pacific Northwest alone are reported to have planted some 60 million seedlings during the past 10 years

MOST of the badly deforested areas are the result of repeated fires which destroyed the natural sources of tree seed. Only by extensive seeding or, preferably, by planting small trees can these lands be brought back to productive forests. This calls for the maintenance of tree nurseries where seedlings or transplants can be grown preparatory to planting them on the fire-scarred stretches.

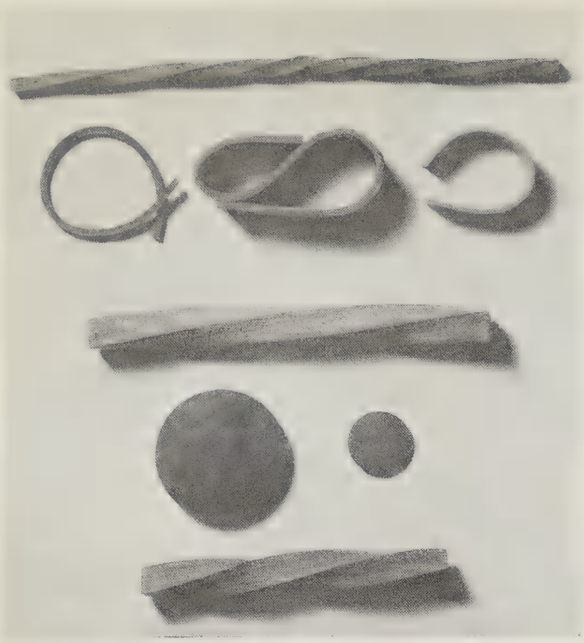
One representative example of an industry-operated nursery is the "tree factory" at Nisqually, Washington, where 25 million seedlings are being produced to reforest burned-over areas. Here are employed the latest scientific developments, including treatment of the soil with tear gas to kill weeds, selection of the seeds according to the location of their parents in order to select seedlings best suited for various soil sites and elevations, and a toughening treatment for the tender seedlings to build up their resistance and ability to survive after they are transplanted and "on their own." More than $500,000 is being spent on this nursery to supply seedlings with which to restore the forest on thousands of acres in Washington and Oregon. The Nisqually Nursery project represents real progress toward the goal of the forest industries—to keep the forestlands continuously producing crops of trees. In the Pacific Northwest alone the forest industries have planted 60 million seedlings in the last ten years.

Admittedly, planting is only feasible as a means of correcting mistakes or repairing disasters. It is neither practical nor economical to rely on artificial propagation alone to maintain forest growth and insure continuous yields of timber. This can best be accomplished by working with nature to assure seed sources, to keep to a minimum the ravages of fire and disease, and to apply the principles of tree growth. Scientific forestry, therefore, comes into the picture at the very source, out in the woods where the fallers and buckers are operating.



Tear gas, introduced into the soil with this specially devised tractor-drawn plow and roller, is being used in continuing experiments to kill weeds at the Nisqually Nursery

RULES for conservative cutting vary according to the kinds and sizes of trees being harvested, the locality, and a variety of other conditions. Where trees of differing ages grow together, and especially where the forest consists of several kinds of trees, with young and old together, the generally accepted practice is to cut selectively. This term is applied to an operation where only trees over a certain minimum diameter, together with those which are defective, are harvested.



By a special treatment process it is possible to bend and twist certain woods to such shapes as these, shapes that will be permanently maintained

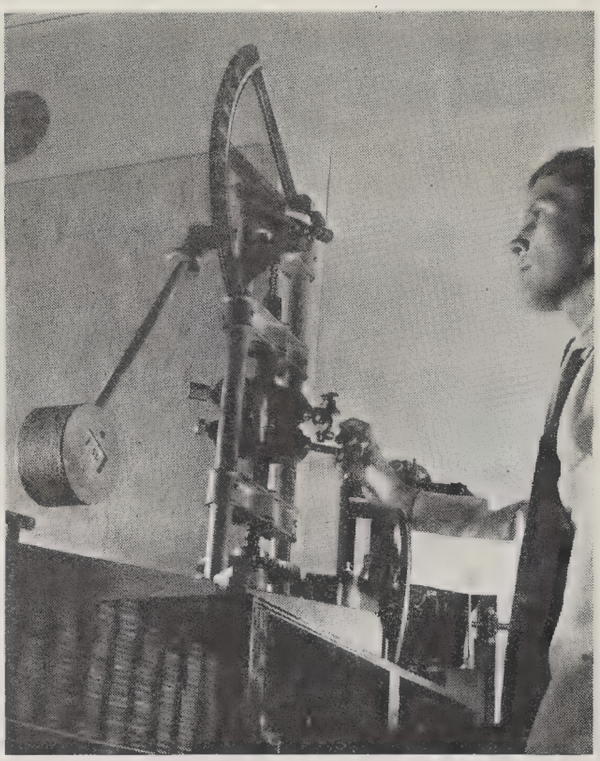
The smaller trees are left to make further growth and to provide seed for restocking the openings. Stands of trees that are growing too thickly may be thinned to hasten the growth of those that are left. Selective cutting is also adapted to stands which are used for more than one purpose, as in the South, where one operation may yield sawlogs, turpentine, plywood, and fuel.

Some kinds of trees demand direct sunlight in early youth, and languish in the shade. Accordingly, they often develop large areas of one-age forests. This is particularly true of Douglas fir in the Northwest where often most of the trees in a given stand are about the same age and, generally speaking, the same size. It may be advisable to clear-cut these stands and leave clumps or strips of firm-rooted, large-crowned mature trees to reseed the cut-over area. Under such conditions the seed trees may be the sources of fertile seed to cover the surrounding land for several hundred yards. After the area is fully stocked with young trees, the old seed trees may be, and often are, harvested.

Regardless of the difference in operations, forestry aims to perpetuate the forest. At the same time, it must be accompanied by continuous efforts to protect the young, growing forest from fire.

Definitely planned cutting to assure continuous forest growth is relatively new in this country. So also are the efforts of the states, the federal government, and the timberland owners to protect all forest growth from fire. Many timbermen in the East and South, however, are harvesting third- and fourth-growth timber, whose each successive crop is the progeny of seed trees left from earlier cuts.

The expanding program of forest management for continuous growth has been popularly called "tree farming." Its practice includes larger industrial operators as well as many thousand forward-looking owners of farm woodlots. Of the nation's commercial forest area, 39 percent is held in industrially productive private ownership, 21 percent is in National Forest reserves or other forms of public ownership, and 40 percent is in farm woodlots. The Pacific Northwest holds nearly half the virgin saw-timber stand, all of which is under protection, and an increasing proportion is classed as managed "tree farms."



In this plywood testing machine, specimens are pulled apart to show relative strengths of the wood and glue. The wood must rupture before the glue

Since young and middle-aged trees grow most rapidly, managed cutting increases the efficiency of forest-land. In general, trees should be harvested when they reach an age when their annual growth begins to taper off. Since every tree in the forests of this country keeps its growth record in so-called "annual rings" within its trunk, it is possible to sample a few trees in any stand to determine when to harvest for maximum timber yield. In some cases the greatest annual yield is realized when relatively young, immature trees are cut. This is true of Southern pine grown for pulpwood. These trees make excellent pulp, but most of the product of Southern mills is Kraft, or heavy wrapping paper, which need not be white. This is an advantage, since the high resin content of Southern pine makes bleaching expensive. Under careful forest management Southern pines grow to a diameter of eight inches in seven years, which, although admittedly exceptional, can provide 14 or 15 full crops of pulpwood in a century. Under management and protection from fire 300 square miles of Southern pine forest can keep a 500-ton-a-day paper mill in operation forever. As against this, 2000 square miles of Northern spruce forest, not under intensive forest management, may be needed to do the same.

WHERE forest stands have been selectively thinned so that individual trees may receive plenty of light, second-growth pine on Southern "tree farms" are not uncommonly big enough for turpentining in 15 years. In fast-growing sections small sawlogs may be ready for harvest in 20 to 30 years, and whole forest areas under management frequently grow 300 to 400 board feet per acre per year.

The blanket on the floor, the handful of "wool," the hat, are wood products

The great stands of old, untouched timber still in the Pacific Northwest are alone sufficient to supply all the country's lumber needs for many years, were no new trees to grow. As the old trees are harvested, the new growth can meet all of the newsprint demands of the entire country year after year. This is especially true where hemlock, once looked on as a "forest weed," is now used for pulpwood, and where the larger logs are in demand for airplane stock. New forest crops in this region are ready to harvest in 70 years or less.

Fire is the greatest single obstacle to forest growth. Young trees are most vulnerable to fire damage; older trees are protected to some degree by thicker, more resistant bark, and because the more inflammable foliage is higher from the ground. Destruction of young growth and seed sources renders denuded forestland incapable of unaided recovery. More than that, fire destroys much of the fertile soil humus, making difficult the establishment of "tree plantations." Most forest fires are caused by man, either from incendiary motives or because of carelessness by smokers, campers, hunters, fishermen, and picnickers. To offset this, workers in the woods are almost extravagantly careful of fire. Some might think the adjective ill-chosen, but woodsmen and foresters know that no extravagance is more unforgivable than a blaze that sweeps through the woods.

Together with insects and tree diseases, fire accounts for 15 percent of the annual use and loss of forest products, the other 85 percent being consumed by man. If the first three of these factors could be controlled, new tree growth would soon balance the needs of industry and home uses, despite the tremendous demands of the war.

Constructive cutting practices, therefore, protect seed sources and provide thorough-going fire protection, while unproductive and burned-over areas are restocked with nursery-grown seedlings. These, together with effective utilization of all harvested trees, are the basis of the "tree-farming" program which is the forest industries' assurance that American industry will not lack wood.

Courtesy "Taylor-Rochester."

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How's The Weather?

Odd Weather Predictors, Some of Which Can be Shown to Have Little-Known Scientific Backgrounds

MANY "signs" have been used by humans to foretell atmospheric conditions. Although a number of these have little or no value, others may be the basis of reasonably accurate predictions. The following are random selections of nature's odd weather gages.

Previous injuries are often used as storm indicators. How often have we heard statements like the following: "Well, I believe it will rain. That lame foot of mine is aching."

Such previous injuries may give more trouble before or during the beginning of the storm. While prophecies based upon such pathological conditions are not always reliable, their accuracy is far greater than that of the average curbstone predictor.

There is scientific background for such forecasting. The healing of injuries is not as perfect as we may suppose. The tissues, the capillaries, and possibly the nerves heal unevenly. Since the circulation system is sensitive to air density, the capillaries may become sufficiently distended during low pressures to cause pain in varying degrees. In other words, the former wound acts as an indicator for low pressure much as a barometer does, although less perfectly. As a low barometer indicates an oncoming storm, so does the former injury.

Other ailments: People with rheumatism, arthritis, or other ailments can also predict storms for similar reasons. Neurotic people and those with poor hearts are often sensitive enough to prophesy atmospheric conditions. More often, people's dispositions are enough impaired during lows so that others may use them for living barometers. Sleep of otherwise normal humans is interfered with during periods of lowered pressure.

This condition must not be confused with that of people who go to higher altitudes. The atmospheric density becomes less as one goes upward, but the aches and pains one feels during steep climbs by train or auto have nothing whatsoever to do with the weather conditions.

People who are sensitive to changes in atmospheric pressure often go to a doctor unnecessarily. The conditions which cause their discomfort are harmless and temporary. If such persons possessed a barometer and watched it carefully, they would be able to tell the serious symptoms from those due to lessened air densities. A microbarograph would be ideal, but an ordinary aneroid barometer would also be quite satisfactory.

WIND caves have the peculiar quality of acting as natural barometers. Caves with enormous capacity may have limited exits to the atmosphere. During high pressure the atmosphere will be forced into such caves. During lowered or lessened "outdoor" densities the accumulated air will blow out of the vents. Wind Cave of the Black Hills is such a cave, but there are others, like the Medicine Hole of the North Dakota Killdeer Mountains, which acts in much the same manner. Although less accurate than a barometer, due to suction of winds and perhaps other causes, the movements of air currents in caves are quite useful as weather indicators.

Wells and Springs: In late medieval times in Italy there were some wells which acted queerly. On most days they would produce water by pumping, but it was observed that on days preceding a storm they would not. The failure to yield water was used as a storm predictor by some. Others attributed magical properties to such a knowing fluid and either shunned or sought (depending on the temperament of the individual) the liquid because of its supposed supernatural properties.

However, the scientific explanation is the simple one. The valves of the pumps used at that time were often considerably above water. It would be hardly possible for pumps to operate 30 feet above the level of the liquid under the best conditions, and almost impossible under usual conditions, yet excessive pumping frequently lowered the well to this critical stage. During the low barometer such pumps tended to protect the well against excessive depletion. The well, therefore, predicted weather about as efficiently as a crude barometer.

Springs and wells sometimes become

"milky" or cloudy before storms. In many instances these are used as local weather forecasters. This seemingly peculiar phenomenon also can be explained scientifically. All flows from underground sources dissolve some gas. Under heavy pressure more gas is dissolved than under low pressure. If the air density is high, gas does not flow or form easily on coming to the surface. If the pressure is low, however, enough tiny bubbles will form to give the water a temporary milky appearance. Often the particles of released gas will bring into the spring or well the sediments deposited during other periods. These may remain suspended and give the liquid a murky or milky appearance. Also the flow may be increased a little during such periods. The spring is therefore like a very crude barometer and, as such, can be used for forecasting purposes.

Moisture phenomena are often used for amateur forecasting. Hazy air gives evidence of the abundance of water vapor. As such, it may be a crude indicator of rain, and because aqueous gas is lighter than air, it is a crude gage of barometric pressure. The "ring" or "rings" around the moon, the halos, coronas, and similar phenomena likewise predict rain.

Human hair is sensitive to atmospheric moisture. Naturally curly hair becomes more curly when the air is damp. Artificially fashioned hair, even the press of one's woolen trousers, tends to go back to the natural state under such hygroscopic conditions. Scientists have recognized the significance of this truth in constructing one of the water-vapor testing instruments, the hair hygrometer.

Landscape features are popular as weather guides. If a mountain or butte to the west becomes unusually hazy or is obscured by a certain type of cloud, a storm will soon be upon us. But this is because weather in our latitude usually travels from the west and we are merely observing it in advance. Pikes Peak of Colorado and Crow Peak of the Northern Black Hills are examples of this type of indicators.

Rainbows in the west also fortell an oncoming rain. But they always occur in the early morning, on rain which is already falling a short distance to the west and which in all probability soon will reach us.

The foregoing indicators are of considerable scientific interest. In no case, however, are they as reliable as the devices used by the weather forecasters. If one lives in an area where such phenomena cannot be conveniently observed, it is some satisfaction to know that good instruments, intelligently used, are much better than nature's weather gages.

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FLOATING GLASS

Made By New Process, Has Many Potential Uses

A NEW type of opaque glass that floats like cork and can be used as the buoyant element in the construction of life boats, life rafts, life preservers, and pontoon bridge supports has been developed by the Pittsburgh Corning Corporation. The new product, called Foamglas, also has valuable insulating qualities. It has a weight of only ten pounds per cubic foot—one fifteenth that of ordinary glass—and is odorless, fireproof, and vermin proof.

It is now under active investigation by certain Federal government agencies as an alternate material for such critical products as cork, balsa wood, cellular rubber, and kapok, which are largely imported. Foamglas does not resemble any form of glass heretofore manufactured. It is extremely light in weight, opaque, rigid, and has a cellular structure containing a myriad of tiny air-tight cells which give it buoyancy and insulating properties.

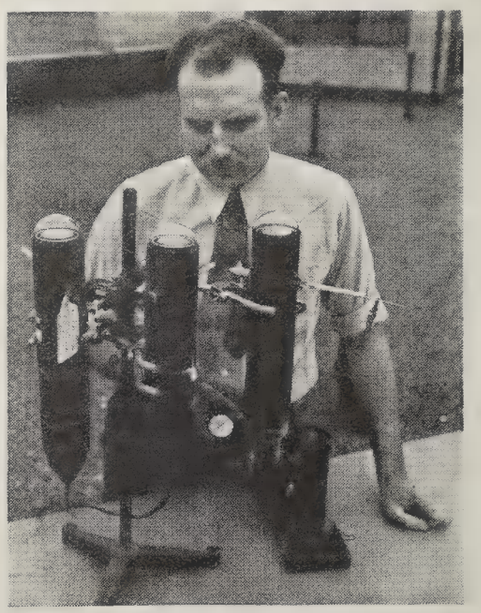
It can be sawed or drilled with ordinary tools. Because of its closed-cell structure it will not absorb water and it will float indefinitely. It is available in slabs 12 inches by 18 inches and in thicknesses of 2 inches, 3 inches, 4½ inches, and 6 inches.

Foamglas is produced by firing ordinary glass which has been mixed with a small quantity of pure carbon. At the proper temperature the glass softens and the carbon turns into a gas which then acts upon the molten glass very much as baking powder or yeast behaves when bread is baked. By proper selection of the glass batch, the type of carbon, and by exact control over the time and temperature used, it is possible to obtain rigid vitreous slabs of Foamglas in which the cells are uniformly small in size and entirely sealed one from another.

SUNFALL

Measured by Use of New Electron Tubes

SENSITIVE new electronic "eyes" developed by Westinghouse engineers to see and record invisible ultra-violet rays in sunshine will be used to make daily measurements of "sunfall" in the United States to study its effect on the wartime health of the nation. The new sun-measuring instruments eventually will operate in 20 of the world's first solar observation posts to be set up for a nationwide ultra-violet study by the United States Weather Bureau. By recording the amount of ultra-violet which penetrates through the haze of big metropolitan centers, Weather



Measures sun tan rays

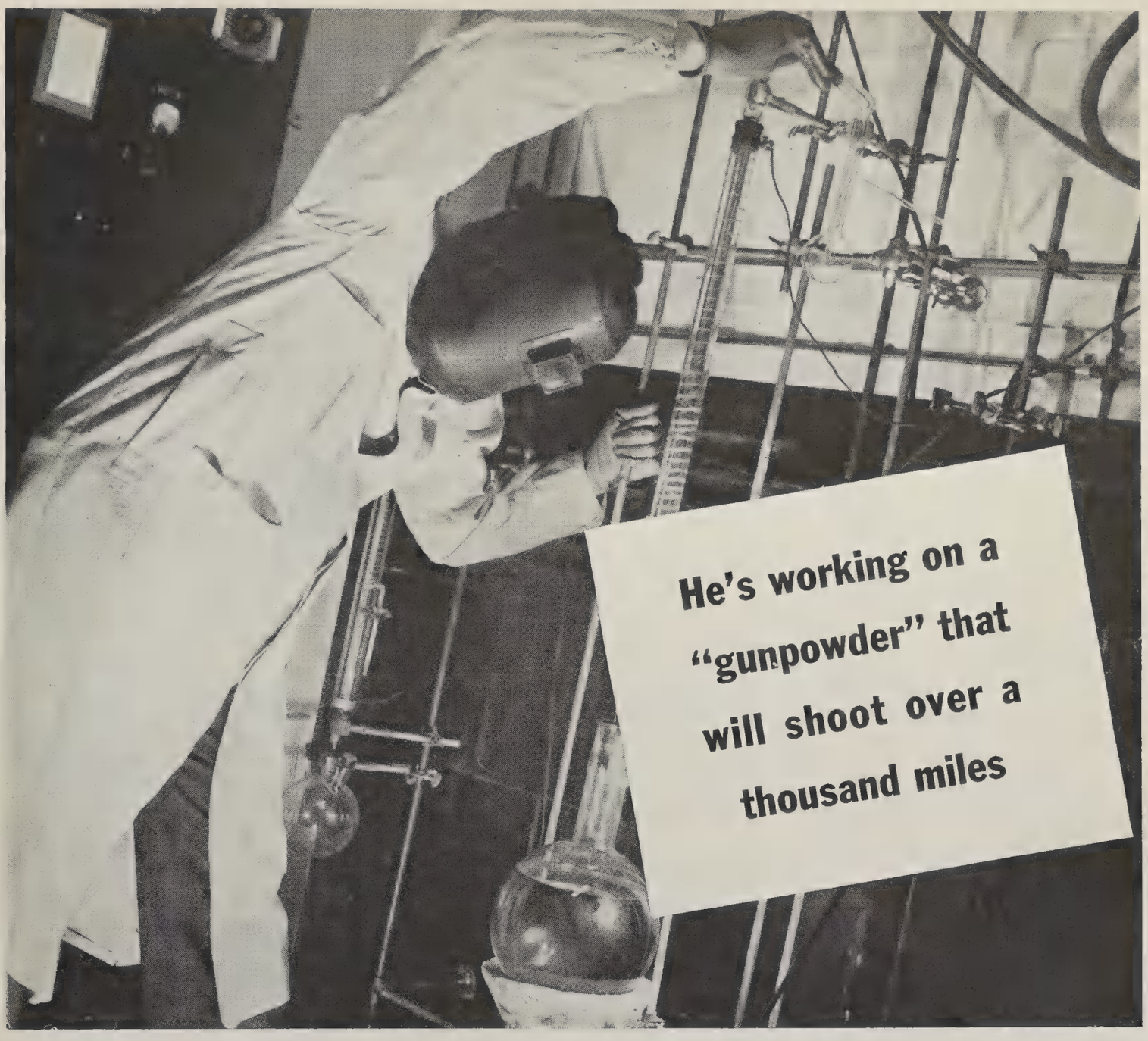
Bureau officials believe that it may eventually be possible to forecast for several days in advance the intensity of sunfall over a city.

Development of new electronic light cells in the meters will make sunfall measurements as accurate and uniform as the familiar rainfall statistics now issued by the Weather Bureau, according to Dr. H. C. Rentschler, Director of the Westinghouse lamp research laboratories.

"Many of the effects of the sun's invisible ultra-violet rays on human health are still a scientific riddle to research men, mainly because of a need for uniform and dependable instruments to measure solar radiations," Dr. Rentschler explained. "Electronics research has now produced a tool that will make it possible to meter and standardize a unit of sunlight just as accurately as a watt of electricity or gallon of fluid.

"Sun statistics taken from various climate zones and compared with the health statistics of those zones will be one way in which research men can study the effect of ultra-violet on humans. Such studies could be aimed at determining what preventive or curative effect, if any, sunlight has on such diseases as tuberculosis and rickets and the relationship between liberal exposure to ultra-violet and general health," Dr. Rentschler said.

In appearance, the ultra-violet sun meter resembles a long, oversized



The black powder of the American Revolution could lob a cannon ball about a mile. At the time of the First World War the normal heavy artillery range, with smokeless powder, was about twenty miles.

For this war, chemical research developed a propellant that has a range of hundreds—even thousands—of miles. Already it has carried four-thousand-pound projectiles from somewhere in England straight to the heart of German industry. It has dropped destruction on a Japanese fleet that was nearly a thousand miles from our outposts. From "Shangri La" it sent all Tokio scurrying for cover.

The new "gunpowder," which has changed the whole strategy of war, is *high-octane gasoline.*

In modern aerial war the bomb is the shell, the airplane is the cannon and high-octane aviation fuel is the propelling charge. The side which has the best aviation fuel—the one which gives the most power, the greatest range per gallon—enjoys an advantage of tremendous value.

Fortunately for the United Nations, the development of high-octane gasoline was a triumph of the American petroleum industry. Long before Pearl Harbor, U. S. petroleum chemists were seeking and finding new and better components for aviation fuels—iso-octane, Ethyl fluid and many others—developing processes and facilities for producing these aids to high-octane quality in volume. They advanced the art of refining petroleum from a simple distilling and cracking process to a science of synthesizing special chemicals—then blended these chemicals into fuels of predetermined characteristics and quality. Since Ethyl fluid plays an important part in the manufacture of high-octane fuels, Ethyl research engineers have cooperated with petroleum technologists in their search for better fuels. And because fuels and engines are inseparably related in their development, we work with engine designers in their efforts to get the most from these superior fuels. Today it is our privilege to furnish our product and devote our technical experience to the cause of American victory.

ETHYL CORPORATION
Chrysler Building, New York City

Manufacturers of Ethyl fluid, used by oil refiners to improve antiknock quality of aviation and motor gasolines.

radio tube. At the upper end of the instrument is a flat metal button about the size of a half dollar and surrounded by a circular wire electrode. The metal in its refined state is sensitive only to that portion of the ultra-violet in sunlight which produces sunburn. The sun's rays, striking the surface of the disk is a nearly perfect vacuum, cause the metal to release a stream of photoelectrons which travel to the electrode. This current is so small that it must be expressed in millionths of watts, or microwatts.

From the electrode, photoelectrons pass to a tiny condenser, actually an "electronic bucket" which stores up the energy over a period of seconds and then releases it in a single charge across an electrical circuit in the tube. Each time the condenser discharges its quota of photoelectrons, a sensitive relay "trigger" registers a sharp click which reveals that a known quantity of ultra-violet is reaching the earth. The number and frequency of clicks provide research men with the total quantity for any given period of time.

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ENGLISH RATIONING—In England during the first three months of the war 1,000,000 cars were laid up due to rationing of gasoline, the increased price of gasoline and tires, and the greatly increased taxation. The sales in July 1940 were only one-quarter of those in 1938, and purchase of new cars was thereafter forbidden.

• • •

GLASS CAMOUFLAGE

Fibers Employed As Covering for Nets

GLASS, ordinarily thought of as a substance used to reveal rather than conceal, today is helping to conceal America's vital war plants against the day when they may become the target of enemy bombers.

Because they are light in weight, don't decay, are unaffected by fresh or salt water, and will not burn, fine, flexible glass fibers thinner than a human hair are being used as the covering, or garnish, for the metal-mesh camouflage nets which are employed to hide strategic war production plants and other possible bombing objectives from enemy raiders.

The glass fibers, manufactured by Owens-Corning Fiberglas Corporation, are spread over chicken wire and painted with designs that blend with the surrounding terrain, whether it be cultivated fields and orchards, or the houses and gardens of a village or suburb.

The fibers can be painted as often as necessary to keep the camouflage design in harmony with seasonal changes in the appearance of the surrounding countryside. Since the combination of metal and glass is incombustible, the nets cannot be destroyed by incendiary bombs.

• • •

JELLY—Even though the pectin makes jelly jell, it is impossible to produce jelly without sugar. Pectin and fruit juices alone won't do it. Sugar unites the two and is the vehicle which carries flavor.

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WOODEN TIRES

Being Used on Ship-Yard Trailers

TWELVE blocks of hard maple per wheel, soaked in linseed oil for 24 hours and fitted as shown in two of our illustrations, are being used on tractor-drawn trailers in a shipyard

Two views of the method of applying a new wooden tire for trailer use

of the Federal Shipbuilding and Dry Dock Company. These trailers spend most of their time moving 20-ton ship propellers, although it is reported that the wooden-tired wheels will stand up satisfactorily under a load of 50 tons.

The rubber tires that were replaced by these wooden blocks weighed 100 pounds each. It is stated by the shipbuilding company that the wooden replacements are good for from one to two years and probably even longer if the blocks are thoroughly boiled in paraffine before assembly.

NEW POLARIZER

Made From Materials Available in this Country

POLARIZATION is one of the present-day fields where research and production stimulation, together with shortages of raw materials, have put the pressure on scientists and engineers to develop substitute materials which have proved to be more suitable than the products hitherto supplied. Before the war, polarizing materials manufactured depended on alkaloids such as quinine for the basic raw material which, when combined with iodine and other chemicals, produced a crystal of strong polarizing properties. But the shortage of imported quinine and cinchonidine has become acute.

Hence Alvin M. Marks, research engineer, well known for his inventions in the polarizing field, in collaboration with his brother, Mortimer Marks, was stimulated to perfect a new continuous crystalline plastic polarizing film which is made from readily available raw materials produced wholly in the United States. This new polarizer is available as a film or as laminated glass, and the development assures the United States a source of supply of this vital product which is an essential part of our war machine.

Today polarizing material is used in gunsights, range finders, binoculars, telescopes, and sighting devices in general, either as a variable light control or to remove glare. Other uses are for blackout protection, navigational instruments, scientific instruments, non-glare goggles and eyeglasses, polarized illumination to produce non-glare lighting, photography and television, polariscopes, three dimensional movies or still pictures, and so on.

X-RAY

Machine Gives Radiations More Penetrating than Radium

DEVELOPMENT of a direct current X-ray generator operating at a potential of more than 4,000,000 volts makes possible for the first time production of radiation which is more penetrating than the gamma rays of radium and which has an intensity greater than

Wanted: MORE EXECUTIVES!

To help win the war!...and the peace to follow!

Every great crisis produces new leaders. This war is no exception. It has created as great a crisis for business as for our nation, and new leaders are rising to the top every day.

Right now, companies are searching high and low for men of executive ability and training to manage the different departments in new and expanded plants. The war and its demands for production, and *more* production, has thinned the ranks of executives to the danger point. The country needs men of executive ability just as it needs production workers and men for the armed forces.

Where will it find them? Ordinarily there would be enough "officer material" right in the ranks . . . men who had been learning by experience, slowly but steadily advancing in the companies which employed them. That is one way of doing it—the hard way, the slow way. But now time is pressing. Such men are needed not two years from now, but *today* and *to-*

morrow! Where will they come from? Those men will have to be trained, *and the smart ones will train themselves—now!*

How can they do that? Through the Alexander Hamilton Institute's intensive Course of Executive Training.

This executive training, which is described in a book called "FORGING AHEAD IN BUSINESS," can help you to accomplish in months what would otherwise take years—if you could get it at all. It is valuable to men in different lines of business because it covers the fundamentals of *all* business—production, marketing, finance and accounting. It is equally effective for the college graduate or the business man who only finished grammar school.

More than 400,000 men have enrolled for this training and every day reports come in of their promotions, salary increases, new and better positions. Many of these men have become so famous that you will recog-

nize their names instantly when you see them in this booklet.

Send for "FORGING AHEAD IN BUSINESS"

The facts about this executive training are given in the book "FORGING AHEAD IN BUSINESS." This 64-page book has inspired thousands of men. Many say it started them on the road to real business success.

A word of warning. If you are *not* interested in executive training, don't send for this book. But if you *are* interested in this way to better your position and increase your earning power, then we want you to have a copy of "FORGING AHEAD IN BUSINESS" with our compliments. Simply fill in and mail the coupon, and the book will reach you by return mail.

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that of the entire available world supply of radium. The new generator was announced in a paper presented by Dr. John G. Trump, its designer, and R. W. Cloud who described construction of the apparatus, while a paper by Dr. Richard Dresser of Boston reported the preliminary clinical observations on the use of these high voltage X-rays. The papers were presented at a meeting of the American Roentgen Ray Society.

The new generator, developed at the Massachusetts Institute of Technology, the design of which is based on the Van de Graaff type of electrostatic high-voltage machine, consists of a dome-shaped high-voltage terminal about two feet in diameter supported on a column of alternate insulating and metallic spacers. A single insulating belt 12 inches wide travels at high speed within the column and transfers an electrical charge continuously between the ground and the terminal. This assembly is mounted within a sealed metal pressure tank in order that by compression of a mixture of air and Freon gas the electrically charged belt, terminal, and column may be insulated. This tank is four and one half feet in diameter and 13 feet high.

In operation, a negative electric charge is sprayed on the insulating belt at its lower end and carried up into the high-voltage terminal, which thus acquires a negative electrical pressure in direct proportion to the stored electrical charge. The voltage may be adjusted from a few hundred thousand volts to the maximum of more than four million volts by controlling the current sprayed on the charge-conveyor belt. The X-ray tube is fixed vertically within the generator column. A metal extension of the tube passes out through the bottom of the tank and terminates in a water-cooled gold target surrounded by lead shielding and provided with beam-defining portals and shutter. The tube consists of 100 glass rings between each of which is placed a metallic accelerating and focusing electrode connected to the generator column. The electrons for producing X-rays by bombardment of the gold target originate at the tungsten filament in the high-voltage terminal end of the tube and are progressively accelerated and focused as they are propelled down the tube at the gold target.

In describing the clinical uses of the highly penetrating radiation of the new generator, Dr. Dresser reported that the rays have essentially the same physical properties as the gamma rays of radium, but that their high intensity permits long treatment distances with the result that the depth dose is much greater than it has been possible to obtain in radium therapy.

Treatment with the high-voltage deeply penetrating X-rays produces no visible skin reaction. The first X-ray generator of the type just described was developed in 1937 to operate at a potential of 1,000,000 volts. A second and more compact unit operating at 1,250,000 volts was built

D.C. generator and its pressure tank

in 1940 for the Massachusetts General Hospital where it is in operation. The latest unit, still more compact than any of its predecessors, is operating in a special laboratory at the Massachusetts Institute of Technology, where therapeutic investigations with 3,000,000 volt rays are made under the direction of Dr. Dresser. In view of the fact that clinical experimentation at high-voltages is still in a preliminary stage, Dr. Dresser made no report on the therapeutic effects of the radiation.

NEW RUBBER

Ready to be Put to Work When Needed

A NEW and purer form of natural rubber was described in a paper delivered by Dr. John McGavack of United States Rubber Company at a recent meeting of American Chemical Society. The new rubber is called USF-rubber and is a new crude of improved properties, according to Dr. McGavack. It was designed to satisfy the demands expressed by the consumers of the crude rubber. Its points of superiority include a greater uniformity for easier processing; softness, requiring less power in milling; greater resistance to flex-cracking; good color; and cleanliness and purity of a high order.

The process for preparing the new USF-rubber has three main steps: First, dirt is removed from the preserved latex by a sedimentation method. The latex is then blended in large storage tanks to obtain and maintain a uniform quality of latex with a definite proportion of total solids. Finally, the rubber content of the latex is flocculated in small particles by a new technique instead of being coagulated by acid in a larger mass. In the flocculated form the rubber particles are themselves purer and may more easily be washed free of soluble impurities.

"It is unfortunate that this development which required so many years of research cannot immediately be put at the disposal of American industry," Dr. McGavack stated. "However, we now have the process and are ready to put it to work wherever needed, in plantations of the west now and later in the plantations of the far east when they have been recovered."

MILITARY MOVIES

Now Being Made With Finest Equipment

THE Air Corps movie-makers "are there with their cameras" at every important maneuver, and they co-operate with the newsreel cameramen in making Army aerial subjects. They also co-operate with major production companies in Hollywood, in technical advice on military subjects.

The big fireproof film library at Wright Field contains motion-picture records of Air Corps maneuvers and special events dating back to remarkably clear, if somewhat jerky, motion pictures of the tests at Fort Myer, Virginia, of the first Army airplane purchased from the Wright brothers in 1909.

Improved sound recordings are being obtained through use of recently installed sound equipment said to be unequaled between New York and Hollywood. The equipment mixes sounds from four separate sound tracks. The commentator talks into a microphone in a soundproof recording room, while separate sound tracks are made for background effects, and the tracks are blended with proper modulations to get the finished film sound track.

Wright Field Aerial and Movie Laboratories are equipped with newest-type processing equipment, and the movie laboratory processes all motion pictures shot at Wright Field.

Technical motion pictures produced by the Air Corps Motion-Picture Laboratory for Air Corps instruction are produced by Hollywood-trained personnel. An animation studio keeps a

staff of artists busy making pictures for animated cartoon sequences in the technical films. Animation has been used for years by the Air Corps in showing technical procedures, because through its use it is possible to point out precisely the essential details in a new piece of equipment without the nonessentials.—*Kodak Magazine.*

SUB LINER

Used in Battery Rooms to Prevent Corrosion

A LINING for the battery rooms of submarines is being produced on equipment which heretofore has been used in production of Goodyear's Plioweld, an interior surface for storage tanks and similar items.

On submarines, the walls and floors of the battery room are lined with rubber or composition sheeting to protect the steel walls from corrosion by escaping battery fluid and fumes. Sometimes, Goodyear officials explain, fluid escapes from the batteries as a submarine lurches, lists, or dives at sharp angles. With the new wall protection, the fluid merely flows down the sides of the battery room to be collected in special disposal equipment.

The lining is usually installed to a quarter-inch thickness over each battery room wall and floor. It is applied in two layers, each about an eighth of an inch thick, and is cemented to the submarine battery-room walls.

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MINT—There has recently been more than a 20 percent increase in peppermint acreage in Indiana and Michigan, to provide for at least part of the 400,000 pounds of menthol which formerly were imported from China and Japan.

• • •

FERTILIZER

War Should Assure Ample Nitrogen Supply

THE more recent increases in domestic capacity for synthetic manufacture of nitrogen should guarantee plenty of that product for fertilizers and every other conceivable agricultural and industrial use when the war ends, says a recent issue of the Du Pont "Agricultural News Letter."

American farmers annually require commercial fertilizers carrying enough nitrogen to supply the explosives requirements of around eight million 24-foot torpedoes or ten million 600-pound bombs.

Every time a 16-inch gun is fired, 120 pounds of nitrogen goes back into the air from whence it came. This means that the nitrogen needed annually by our farmers, along with such other plant-food elements as phosphorus and potash, to grow the food, feed, and fiber demanded of them, would, if converted to explosives, be sufficient for well over seven million 16-inch shells.

In 1910 American farmers used less than one-third as much fertilizer nitrogen as they require today. The increase from 260 million pounds in 1910 has been rapid and steady: 404 million pounds in 1920; 694 million in 1930; and 866 million in 1937, the last year a complete survey was made.

If all the nitrogen now needed annually on American farms had to be supplied by imported nitrate of soda, as was largely the case during World War I, it is conservatively estimated that American farmers would require more than 2,700,000 tons of nitrate of soda during the current year.

At the outbreak of World War I, the United States did not have a single manufacturing plant to extract nitrogen from the air. However, since then the chemical industry has developed nitrogen fixation plants. No longer are we almost wholly dependent on foreign sources or on the high-

THE ARMY-NAVY "E" Flag awarded to Bausch & Lomb recently for continuous achievement in production for Victory is the third in a series of "E" awards. Previous awards included the original Navy "E" and the All-Navy "E" Burgee with star.

"Eyes Right" Has Never Meant So Much To America

EVERY job in Production for Victory calls for top visual efficiency. This means that eyes must function unfailingly and unflinchingly—at lathe, bench and on assembly line, in research and control laboratory, over drafting board and foundry flask.

Upon the skill and training of the nation's thousands of eyesight specialists rests the responsibility of forestalling eyestrain as an unconscious saboteur.

As a maker of ophthalmic products—the instruments used in the scientific examination of the human eye, the spectacle lenses and frames which these specialists use—Bausch & Lomb has an important part in America's war effort.

In the development and manufacture of actual fighting equipment, such as rangefinders, aerial height finders, binoculars, aerial map-making equipment, Bausch & Lomb is serving the Armed Forces directly. At the same time, Bausch & Lomb is providing the metallographic equipment, the microscopes, spectrographs, contour measuring projectors, optical glass and special instruments required by other manufacturers in filling military needs.

BAUSCH & LOMB
OPTICAL COMPANY • ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR MILITARY USE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

priced domestic organics of vegetable and animal origin for nitrogen. However, these sources, plus domestic sulfate of ammonia, continue to constitute the current wartime nitrogen-carrying materials allocated to fertilizer use. All synthetic nitrogen is being used for purposes other than fertilizer.

If it were not for the greatly expanded domestic synthetic nitrogen capacity, imports of nitrates would be utterly inadequate for our current needs. In fact, after combining both domestic and imported sources of nitrogen allocated to fertilizers, the manufacturers in that industry face some shortage for the coming season.

Old-fashioned organics, one of the important sources of fertilizer nitrogen at this time, include the vegetable and animal proteins such as oil-seed meals, dried blood, animal tankage, and fish products. However, the trend before the present war was definitely away from these organics and toward increased use of the newer synthetic organics and inorganics. There is every indication that this trend will continue after the war.

Imported nitrate of soda was the only important source of inorganic nitrogen up to and including 1900. Beginning with 1910, ammonium salts, chiefly from by-product coke ovens, also became an important source of fertilizer nitrogen, nearly always exceeding the tonnage of nitrate nitrogen.

As recently as 1925, not a pound of liquid ammonia was used in fertilizers manufactured in the United States but, as the result of practical application of the findings of research, more than one fourth of the nitrogen used in mixed fertilizers in this country at the outbreak of the present war was supplied by various kinds of ammoniating liquors. These give promise of playing an even greater role in fertilizer production after the war.

• • •

WOOD LIFE—For every 1000 board feet of lumber treated with effective wood preservatives, an equal amount of wood products is saved for war use when the treatment given doubles the service life of the treated product.

■ ■ ■

BLACKOUT TAPE

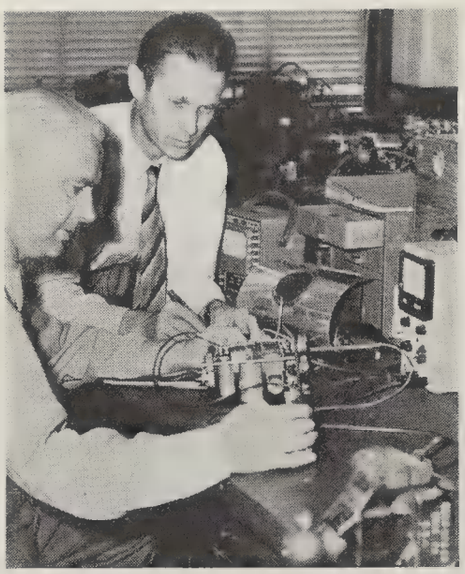
With Adhesive Back and Phosphorescent Front

A PHOSPHORESCENT tape available in one yard rolls, one inch in width, has an adhesive back for application to surfaces surrounding openings, obstructions, and so forth. This new tape, made available by the General Luminescent Corporation, will glow in the dark for a period of eight to twelve hours after it has been activated.

ICE INDICATOR

Removes One Worry from Pilot's Mind

A NEW electronic device which signals and measures ice forming on airplanes in flight, and automatically operates the plane's de-icers, should go a long ways toward improving the efficiency of Allied bombing planes. Developed at the instigation of commercial airlines and the United States Army Air Corps, the instrument is the result of protracted research in laboratories of the Minneapolis-Honeywell Regulator Company and in flight tests over the worst icing territory in the United States.



Ice indicator in the laboratory

According to the M-H president, the need for accurate measurement of the accumulation of ice on plane wing surfaces has been acute since winter flying became mechanically possible. De-icing equipment is now standard on commercial airlines and most long-range military planes, but to operate at maximum efficiency, the de-icer must be turned on when the ice can best be cracked off.

"The 'Ice Indicator' provides the pilot with information on the thickness and rate of accumulation of ice on exposed plane surfaces," he stated. "For the first time in flying history de-icing equipment can now be turned on at the exact moment it becomes most efficient."

The indicator itself is composed of three separate units and utilizes principles of electricity for its operation. A "pick-up plate" or sensing element is mounted on wing or plane surface where ice accretion is to be measured. This plate, which is very small, is set flush with the plane so as not to disturb the air flow. It contains parts which actuate the mechanism by noting the accumulation of ice. The plate is connected to an amplifier inside the wing, which in turn is connected to a power supply unit. The latter does the actual work of turning on the de-icers and registering accumulation on an instrument board meter. The entire indicator weighs under five pounds.

MELAMINE AGAIN

For Buttons and High Wet-Strength Paper

TWO new applications of melamine resins for widely different purposes were recently announced by American Cyanamid Company. Buttons molded of melamine resin plastic have withstood the gruelling tests prescribed by the Quartermaster Corps for use on cotton garments, heretofore met only by buttons machined from pearl and from imported vegetable ivory; papers treated with melamine resins have high strength when wet and at the same time have substantially increased resistance to folding.

Melamine resin plastic is the only synthetic material unaffected by the stringent tests of laundering, ironing, fading, decontamination, and impregnation imposed by the Army on buttons for cotton underwear and similar items of issued apparel subjected to the most severe conditions in service. Buttons of other synthetic plastics have been accepted for other garments issued to our armed forces, but now melamine resin plastic joins more expensive fresh water pearl and imported vegetable ivory for making buttons to meet the most severe army service. Because buttons can be molded of synthetic resins without machining, their cost is materially reduced.

Paper retains strength when wet

Melamine resin also is the basis of a new treatment for paper pulp that imparts extraordinary wet strength to the sheet made from it and at the same time increases the resistance of the

sheet to folding. Previous methods of raising the wet strength of paper have required special equipment to treat the sheet after it is formed, and the treated sheet has been characterized by lowered resistance to folding. The effect of older treatments has diminished on prolonged storage under conditions of high humidity. The new treatment is applied to the paper pulp before the sheet is formed, requiring no additional special equipment beyond that usual in every paper mill. The fold resistance of the sheet made of pulp treated by the new method is approximately doubled and no diminution in wet strength or fold resistance occurs on prolonged storage even under unfavorable conditions.

High wet-strength paper, valuable for paper towels, vegetable bags and wrappings, corrugated boxes, and similar services where moist materials are handled, is especially important now in view of the widening use of paper to replace other wrapping materials now scarce.

Another type of high wet-strength paper is a recently announced product of Brown Company. Known as Aqualized paper, this new material is being tested as a substitute for cloth and burlap.

By means of an exclusive process, it is reported the individual cellulose fibres in Aqualized paper are effectively interlocked and fastened, thus giving an inherent wet strength all the way through the sheet, independent of any coating or any sizing. This paper can be made in various types, some of them highly absorbent and some of them so fabricated as to repel water.

This new paper lends itself to such unusual uses as for clothing, Army tents, sand bags, and so on. It is also being experimented with in the food field where it is being used for potato bags, crate liners, locker bags for frozen foods, and so forth.

MERCURY "BOMBS"

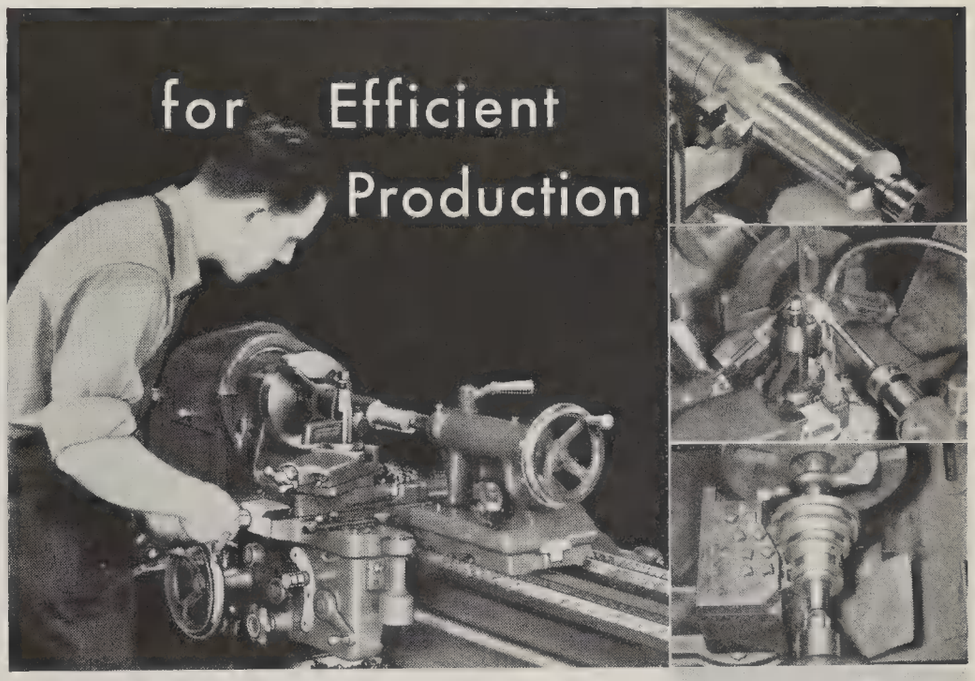
Save Precious Metal in Fluorescent Lamps

How Yankee ingenuity is stretching the nation's stocks of critical materials was illustrated recently by the announcement that Hygrade Sylvania Corporation engineers have cut the amount of mercury used in the manufacture of fluorescent lamps by approximately 50 percent in a process which has the double-barreled effect of saving mercury and of producing improved lamp performance as well.

Basis of this process is a mercury "bomb" which is exploded in the interior of the lamp during manufacture, ejecting the exact amount of mercury needed, and eliminating the wastage resulting from previous methods.

Mercury, high on the list of critical materials, is essential to the operation of a fluorescent lamp, because fluorescent light is caused by the action on fluorescent materials of ultra-violet rays emitted by electrically excited mercury atoms. Seventy percent of the world's mercury is produced in Spain and Italy, supply sources now closed to the United Nations. The United States produces about half of the remainder, but even in normal times has been forced to import substantial quantities of the metal. The loss of foreign sources skyrocketed the price from $84 a flask in August, 1939, to $202.50 in January of this year. Marginal mines were brought back into production under this favorable price situation, resulting in a 16 percent increase of production, but this has been insufficient to meet the swelling demands of wartime industry, even with the addition of almost all of the Mexican output, which heretofore had been exported to Japan. Stocks dwindled to 12,000 flasks in late 1941.

Under the old method of manufacturing fluorescent tubes, a mercury dispensing device dropped free mercury into the lamp during the exhaust process. It was done automatically, but the process had many drawbacks. First, there was an unavoidable waste of mercury; second, the mercury and the dispensing parts had a tendency to become contaminated, causing further waste; third, and most important, it was impossible to maintain the exactitude necessary for best lamp performance. Some lamps received too much mercury, which resulted in heavy streaks, shadows, and dark end-discoloration in the lamps under operating



SOUTH BEND LATHES

Equally efficient on precision toolroom work or close tolerance manufacturing operations, South Bend Lathes will help solve your production problems. Substantial savings in capital investment, power consumption, floor space, and labor costs have resulted from their installation. They will give you the same efficient, trouble-free service that they are giving some of the largest war industries.

Many features contribute to the efficiency of South Bend Lathes. A wide range of spindle speeds permits maximum cutting tool efficiency. Smooth, vibration free operation permits machining work with such precision that subsequent finishing operations can often be eliminated. A convenient arrangement of controls makes for an ease of operation which reduces fatigue and lowers the probability of errors.

Made in a wide range of sizes and types, there is a South Bend Lathe that will efficiently handle almost any class of lathe work. Write for catalog and name of our nearest dealer.

"HOW TO RUN A LATHE"

A practical reference book on the operation and care of metal working lathes. Widely used for training apprentices, new operators and students. Contains 128 pages, 5⅛" x 8", over 365 illustrations. Price 25 cents, postpaid.

SOUTH BEND LATHE WORKS
LATHE BUILDERS FOR 35 YEARS
SOUTH BEND, INDIANA, U. S. A.

conditions. Some received too little, which makes the lamp a "slumper," or one that fades out after a few hours of burning. Thus the percentage of rejects was unnecessarily high, and it was almost impossible to reclaim the mercury in the rejects.

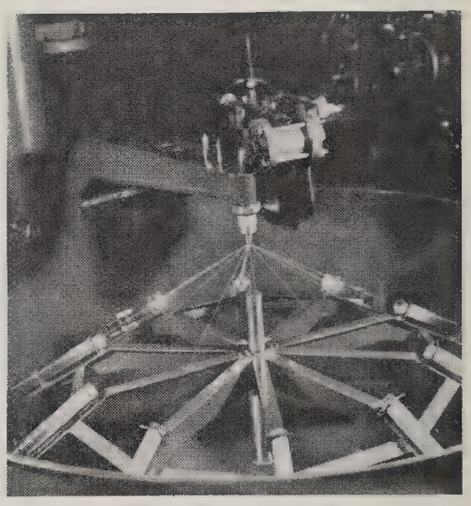
The new "bomb" process "wraps up" the exact amount of mercury needed for the lamp, down to the last milligram, in a tiny metal tube affixed to a support lead of one cathode. When the current is first turned on in the lamp, during the exhaust process, the heat expands the mercury and the tubing "explodes," releasing the free mercury.

Since the tubing length can contain no more than the exact amount, an oversupply of mercury is impossible, and a simple selector device removes from the production line any "bomb" with an insufficient load.

DIESEL NOZZLES

Now Tested for Accurate Delivery of Oil

A TINY injection spray nozzle, smaller than the tip of the little finger is literally the heart of a Diesel engine; the minute holes in the nozzle



Test tubes receive the oil

must be drilled at precisely the same angle to assure uniform injection of fuel. If such uniformity of injection is not obtained, the Diesel cannot operate at its peak efficiency.

These injection spray nozzles employ a ring of holes ranging in number from six to ten, each hole being drilled individually to a diameter as small as 0.008 of an inch. The operation of these holes is similar to that of an atomizer; the smaller the holes, the finer the spray and the more efficiently the oil burns.

The early Diesel engines used compressed air to blow the fuel oil into the cylinders. Then came mechanical or airless injection. Still later came the development, by the Cooper-Bessemer

Smoothly geared to duration living

A home, a headquarters, a stopping-off place ...The Waldorf-Astoria serves duration living needs efficiently, economically...graciously.

THE WALDORF-ASTORIA

PARK AVENUE • 49TH TO 50TH ST. • NEW YORK

Corporation, of the pressure relief type of fuel injection which, in contrast with the constant pressure or mechanical injection system, might be more accurately referred to as a "controlled pressure" system.

For testing the fuel nozzles used in the Cooper-Bessemer engines, a device has been developed to check the accuracy of the tiny holes. During the test, as shown in one of our illustrations, individual nozzles are fitted into an arm overhanging a tank. Around the walls of the tank are placed a number of test tubes, the number corresponding to the number of holes in the nozzles to be tested. When oil is forced under pressure through the test nozzle, each tiny stream of oil must strike the mouth of its particular test-tube receiver accurately, and deliver the correct amount of oil in a specified time. Failure to do this results in rejection.

• • •

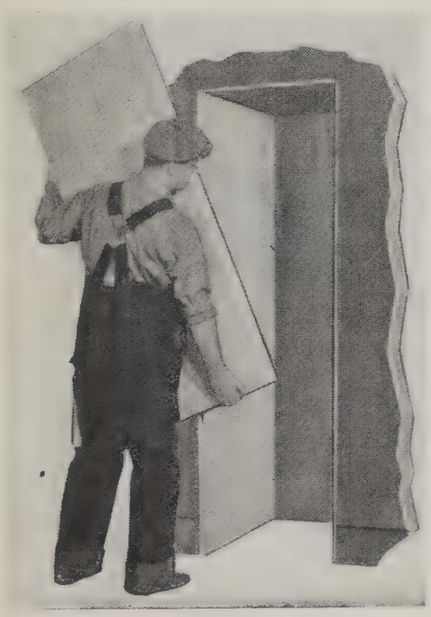
SUGAR—The first successful American sugar beet factory was established in Alvarado, California, in 1879. Nine years later, the second successfully operated beet sugar factory was built, which in that year, manufactured 1000 tons of sugar. Today California leads in the production of beet sugar. In 1941 the state produced 6,182,431 hundred-pound bags of beet sugar.

• • •

SOUND-PROOF

Panels Can be Added to Old Telephone Booths

By placing in old telephone booths a set of newly developed acoustic panels, the old booth becomes sound proof. With the panels in place the old door can be removed, as it is no longer a necessary part of the enclosure. The acoustic panels, manufactured by the

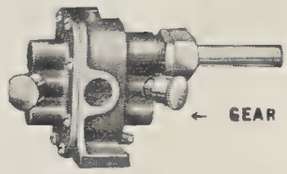


Panels that sound-proof

IMMEDIATE DELIVERY

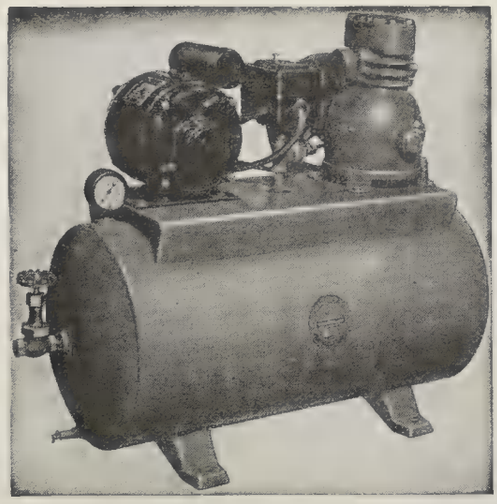
LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT

BRONZE GEAR AND CENTRIFUGAL PUMPS



		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	¼″	⅛″	$ 6.50	$25.00
No. 4	"	¾″	½″	13.50	32.00
No. 9	"	1¼″	1 ″	16.50	35.00

No.	1½	Gear	⅛″	Price	9.00	With A.C. motor	$25.00
No.	2	"	¼″	"	10.00	" " "	27.50
No.	3	"	⅜″	"	11.50	" " "	28.50
No.	4	"	½″	"	12.50	" " "	32.00
No.	7	"	¾″	"	15.00	" " "	37.50
No.	9	"	1 ″	"	16.50	" " "	49.50
No.	11	"	1¼″	"	48.50	" " "	on request



HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Models D H G ¼

12″ x 24″ tank A.C. 110 or 220 v. 60 cycle **$57.50**

16″ x 30″ tank A.C. 110 or 220 v. 60 cycle **$64.50**

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

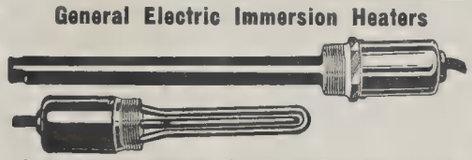
Synchronous Motors

New Emerson 100th H.P., 900 R.P.M. 110 volt 60 cycle hollow 25/32 shaft vertical or horizontal mount, no base. Has many applications...**$7.50**

Small Piston Type Air Pump

Can be used for all purposes where low pressure air is required. Develops 1/3 cu. ft. of air at 15 lbs. pressure. Suitable for aquariums. Takes care of 6 to 8 tanks. Piston type, all brass cylinder. Belt driven. Universal AC-DC motor. Mounted on neat base. Complete. **$7.95**

General Electric Immersion Heaters



Suitable for heating liquids tanks, kettles, etc. (1 KW raises temperature 100° F 3 gallons per hour.) Fitted for 1½″ iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.

600 Watt.....$7.50 1200 Watt $10.50
750 " ..... 7.50 2000 " 12.50
3000 Watt $15.00

MAGNETIC GAS VALVES
All sizes in stock; Prices on request

EXHAUST FANS, BUCKET BLADES
General Electric A.C. 110 volt motors.

	R.P.M.	cu. ft. per min.	Price
9″	1550	550	$12.00
10″	1500	550	13.50
12″	1750	800	18.00
16″	1750	1800	21.00
16″	1140	1650	27.50
18″	1750	2500	22.50
18″	1140	2100	32.00
20″	1140	2800	36.00
24″	1140	4000	42.00
24″	850	3800	45.00

Other voltages & frequencies available at slightly higher prices.

DURAKOOL MERCURY SWITCHES

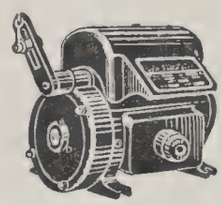
This metal mercury switch overcomes faults of usual mercury switches. May be turned ■ full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	.....$1.10	20 Amp.	.....$3.15
3 Amp.	..... 1.65	35 Amp.	..... 5.50
5 Amp.	..... 1.65	65 Amp.	.....11.00
10 Amp.	..... 2.00	200 Amp.	.....50.00

HEAT REGULATOR OUTFIT

Complete with Accessories! **$21**

G E H Economy Special! —The finest two-piece outfit on the market. Consists of an all electric Minneapolis Control Motor and a General Electric Thermostat. Motor is operated off your nearest light socket and has a built-in transformer supplying low voltage to the room thermostat. The thermostat is adjustable from 50° to 80°.

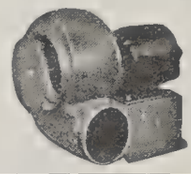


Easily installed on any type furnace.

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4½″	3¾″	$22.00
0½	⅛	1750	350	6½″	3¾″	25.00
1	1/6	1750	535	6 ″	4½″	30.00
1¼	¾	1750	950	7½″	6 ″	37.50
1½	½	1750	1900	9½″	7 ″	75.00

PRICES QUOTED ARE FOR A.C. 110 V. 60 CYCLES ONLY.
OTHER VOLTAGES ON REQUEST.



PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. **NEW YORK CITY, N. Y.**

LONGINES
the most honored watch for a Lady
A Longines Watch for a lady is much more than a charming jewel-like ornament. Within the beautifully wrought case is the Longines "Observatory Movement*", a work of incredible precision, and unbelievable accuracy and dependability considering its tiny size. The photos of the Longines Watch and movement above are both greatly enlarged. The watch is one of several in the smart round design.

Longines

THE WORLD'S MOST HONORED WATCH

The established prestige of Longines Watches has resulted in a demand today greater than necessarily restricted production. Your Longines jeweler will show you the Longines Watches that are available, and all have the dependable Longines "Observatory Movement." Longines Watches have won ten world's fair grand prizes, 28 gold medals and more honors for accuracy than any other timepiece. See also the Wittnauer watch, a companion line outstanding for value at a moderate price—product of Longines-Wittnauer Watch Co., New York, Montreal, Geneva.*

*Trade Mark Registered U. S. Pat. Off.

Burgess Battery Company, are made of reinforced birch plywood filled with a blanket of sound absorbing material, the resulting cellular design giving an adequate sound absorbing effect. The outer surface of the panels can be finished by any conventional method.

PINEAPPLE ENZYME

Can be Used to Make Tough Meats Tender

BROMELIN, an enzyme which, like certain other members of this group, has the property of breaking down meat protein and thus making tough cuts more tender, has been successfully isolated from the peels and cores of pineapples. The technique is said to consist of pressing the juice from the peels and cores at a stage of manufacture at which the juice is of little commercial value to the canner. The bromelin is precipitated from the juice by the addition of ethanol, which can be recovered for use with fresh batches of juice.

DEHYDRATED VEGETABLES

High in Vitamins, Call For Proper Packaging

WHETHER they are being produced for soldiers and sailors overseas, for our Lease-Lend allies, or for our own dinner tables, scientifically dehydrated fruits and vegetables are "delivering the vitamins." According to laboratory technicians, the nutritive value of these space-saving products may be higher for this year's crop than ever before in the industry's history.

As in the case of canned, frozen, or fresh food, vitamin content of dehydrated vegetables depends to a great extent upon the original content and freshness of the raw foodstuffs. Modern dehydrators partly solve this problem by locating their plants in the heart of the growing areas, one of the largest, in California, being within two hundred feet of its own fields.

Optimum vitamin contents of eight typical vegetables have been released by the United States Department of Agriculture, subject to unavoidable variations in the raw stock and other conditions. Arranged in the accompanying table, the figures show vitamin contents found in each 100 grams of dehydrated foods.

The packaging of dehydrated vegetables is an important factor in preserving their maximum nutritive value and palatability and is one of the important wartime projects under way in the laboratories at the New York State Experiment Station at Geneva.

Paper containers of all kinds, cardboard, parchment, foils, waxed linings, cellophane, flexible plastics, and a score of other materials are now under test by the Station scientists. Packages that may meet the necessary requirements for domestic markets may be entirely unsuited for Lease-Lend shipments and for use by combat troops, it is pointed out, because these last two categories require that the package be war-gas proof in addition to the usual requirements.

Different vegetables also present different problems when it comes to packaging. Dehydrated carrots, for example, an important source of vitamin A, deteriorate rapidly and lose color, thus greatly lowering their nutritive value unless the product is packaged under certain conditions. One of the requirements for dehydrated carrots is that the air in the container be replaced with some inert gas, such as carbon dioxide or nitrogen. The Station scientists are carrying on tests with inner liners for packaging carrots. The liners are partially sealed and then the air replaced with carbon dioxide before the final seal is made.

As a final check both of the packaging materials and the packaging processes, the various types of packages under test are being stored in a room maintained as near tropical conditions as to temperature and humidity as possible. After several months' storage under these conditions, the packages will be opened and the contents subjected to various tests, including a taste test, to determine the effect of the packaging and storing on the nutritive value and palatability of the dehydrated products.

	Pro-vitamin A (carotene) milligrams	Vitamin B_1 (thiamin) micrograms	Vitamin B_2 (riboflavin) micrograms	Vitamin C (ascorbic acid) milligrams
Beets	—	40	350	25
Carrots	90	300	300	20
Spinach	40	750	1150	150
Kale	16	500	900	300
Mustard Greens	50	—	—	400
Swiss Chard	3	550	1120	125
Sweet Potatoes	5	200	320	35
White Potatoes	—	425	250	25

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

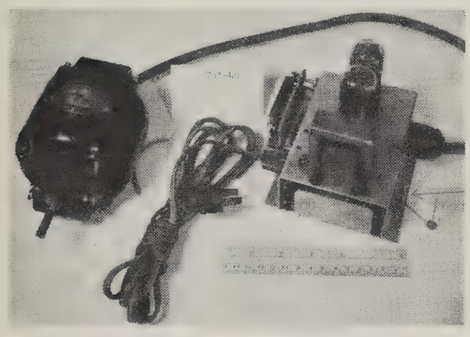
ELECTRONIC CONTROL

For Induction Motors, Operates on Micro-Watts

THE direction of rotation of ordinary single-phase induction motors can be quickly and accurately controlled by means of electric circuits of negligible power and without the use of mechanical or moving contacts of any type through the use of a newly developed electronic control shown in one of our illustrations.

In the photograph an arrow points to the two control terminals, which are to be connected to any suitable control circuit. The control power in this circuit is of the low order of 100 micro-watts.

In the setup shown, the 1/50 horsepower motor weighs about 5½ pounds; the electronic control weighs about 2¾ pounds, or a weight ratio of two



Motor and electronic control

to one. The control, developed by W. C. Robinette, uses two receiving type vacuum tubes of less than one watt rating each.

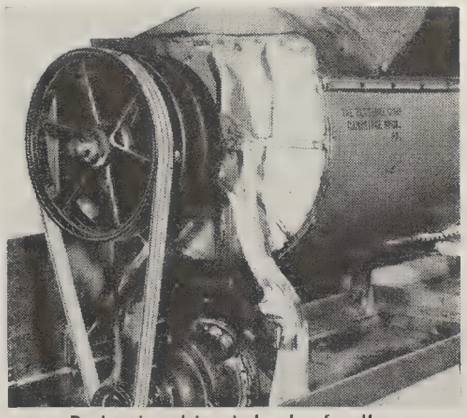
This electronic control of motor rotation is applicable to a number of industrial operations where a relatively small movement of some mechanism or other moving part is to be applied to governing the direction and speed of a motor.

REDUCTION DRIVE

Adapts Motors to Slow-Speed Machines

A COMPACT speed reduction unit that mounts on the shaft extension of a machine to be driven is now available in five standard sizes from ½ to 25 horsepower. The unit, made by The American Pulley Company, is attached to the shaft by means of a keyed bushing and is prevented from rotating by a torque arm which is bolted to the case and to a rigid support.

Within the case of the unit, shown in one of our illustrations, is a compact yet efficient gear train which pro-



Reduction drive is back of pulley

vides a standard fixed speed ratio of 13 to 1. Any differences between this ratio and the desired total ratio can be accomplished by the proper choice of standard pulleys for the primary belt drive. Also, there are available adjustable diameter pulleys which can be employed where operations require frequent or rapid speed changes.

HORSESHOE MAGNET

Speeds Up Welding by Eliminating Arc Blow

A WARTIME version of the old fashioned horseshoe magnet has pointed the way to possible major gains in welding steel plates for war machines.

Savings in man-hours, as well as improvement in quality of welds, are expected to result when the specially designed "magnetic shunt," as the device is called, goes into heavy duty on Army and Navy ordnance materials. The magnetic shunt was used in a series of tests to tame magnetic arc blow, traditional pest of the electric welder.

Magnetic arc blow, according to Charles H. Jennings and Alfred B. White, Westinghouse research engineers, is a tendency often developed by electric welding arcs to be deflected from their course, and thus produce slow, irregular, and frequently inferior

1917 WAR RUN BY TELEPHONE

1942 WAR RUN BY RADIO

For Instance...

...during the Dieppe raid, Gen. Roberts commanded from headquarters on a destroyer. ...along a nine-mile front wireless [radio] messages could be heard coming in... ...a smoke shield was ordered for troops on the "west beach" ...the [radio] order was given to the Fighter Command...two hundred miles away...WITH IN A FEW MINUTES Douglas Bostons were dropping a heavy pall of concealing smoke... (news item)

Interesting!

Watch for radio use in the war news — you'll find it in the air — on the ground — and at home!

WITHOUT radio, the movement of war would still be anchored by telephone lines—the physical hazards of the courier and visual signals.

Now war moves swiftly over the whole face of the earth—instantaneous radio communication thru the ether instead of over copper wires has blasted the barriers of space and time.

So today all our radio production centers on war use.

But what of tomorrow—what effect will this have upon the future—after victory?

One thing is certain—it will revolutionize and speed the great new future form of transportation.

Radio has never been universally necessary in transportation before. In automobiles—on trains—it has been entertainment—in boats it has been a great aid but not an essential.

But today for the future, in that great, new universal transportation that is forming itself—the airplane—radio is essential as the engine itself.

And—mark this well—airplanes and radio are two of the four *great* industries destined to lead this country back to business normalcy after the peace is won.

Zenith's leadership in the radio industry has been established by a constant achievement of "firsts." Repeatedly, ideas "brand new" when Zenith "first" introduced them, later became essentials on all radios. And that same "forward thinking" of engineers and factory and organization now concentrates on war production of the thing we know—radio—exclusively radio. We are progressing—we learn every day—and this new experience will inevitably reflect itself when Zenith again produces for peace.

—a Zenith Radio Dealer near you is giving reliable service on all radios—regardless of make.

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Cells are in excellent condition. Complete with solution, connections and trays. Prices below are about 10% of regular market price. Average life 10 years. Two-year unconditional Guarantee.

A-4	Amp. Hrs. 150	Ea. [illegible]
A-6	Amp. Hrs. 225	Ea. [illegible]
A-7	Amp. Hrs. 262	Ea. 7.00
A-8	Amp. Hrs. 300	Ea. 7.00
B-2(J-3)	Amp. Hrs. 37	Ea. [illegible]
M-8	Amp. Hrs. 11	Ea. 2.00
L-20	Amp. Hrs. 13	Ea. 2.50
L-40	Amp. Hrs. 25	Pr. [illegible]

All cells 1.2 volts each

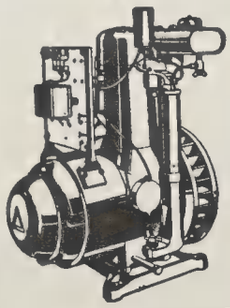
Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

U. S. ARMY TELEGRAPH SET

Signal Corps telegraph key and sounder mounted on mahogany board. Operates on [illegible] dry cells..... $5.95

Lighting Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery start ignition.



Price $225.00

Additional data on request.

HIGH FREQUENCY GENERATORS—AC

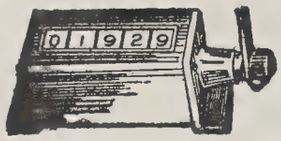
4800 RPM, Ball Bearing, Self Excited.

400 cycle	115 Volts	200 Watts	.....$65.00
500 cycle	115 Volts	250 Watts	..... 80.00
500 cycle	115 Volts	500 Watts	..... 95.00
600 cycle	115 Volts	200 Watts	..... 65.00
900 cycle	110 Volts	200 Watts	..... 45.00

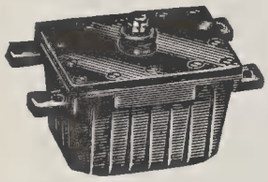
HAND CLINOMETERS, PENDANT

U. S. Army Engineers, Geologists, Surveying, Mapping, etc. Magnifying Eyepiece. $3.50

"Veeder-Root" Revolution Counter



Six number, [illegible] non-reset, dimensions overall 5½" long, 1¼" wide, and 1-5/16" high. Numerals ¼" high, nickel plated. Special... $7.50



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Dubilier, new $12.50
Dubilier, used 10.00
Wireless Spec. new $10.00
Wireless Spec. used $7.50

Condenser, Dubilier, mica, op. volts 8.500. cap. 004 .....$7.50

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in stock
SIZES FROM #39 to .001

U. S. Army Aircraft, solid brass telegraph and radio transmitting key, large contacts. $2.95

Single Stroke Electric Gongs

Edwards 12" bronze DC 5 Ohm Mech. Wound	$18.00
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Schwarze 8" 100 Ohm 32 volt	10.50

Engineers U. S. Army Precision Type Tripods

Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price $4.95

Build Your Own Searchlight

U. S. Army Parabolic Mirror Precision Quality

Dia.	Focal Length	Glass Thickness	Price
30 in.	12½ in.	7/16 in.	75.
36 in.	18¼ in.	7/16 in.	125.

Made by Bausch & Lomb & Parsons. Perfectly ground and highly polished.

A few 60 in. slightly used metal mirrors on hand $225. ea.

TUNGSTEN CONTACT DISCS

1⅜" dia. — 1/16" thick. Pure metallic tungsten contacts. Machined and polished.

$2.00 ea. $3.00 per pair.

U. S. ARMY AIRCRAFT MICROPHONE

Manufactured by Western Electric, Breast type carbon microphone transmitter, noise proof, complete with cord, plug and breastplate. Exceptional value $2.95

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Pocket type 360° Limited quantity. $10.50

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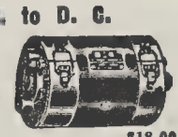
[illegible] in. dia., brass, black enameled, improved pattern, with opening in top, floating jeweled dial. 2 in. Each... $16.50

DYNAMOTORS D. C. to D. C.



24-750 volt. Gen. Electric 200 mills $27.50

24-1000 Gen. Elec. 1000 mills $85.00

12-350 volt 80 mills	$18.00
12-750 volt 200 mills	30.00
32-350 volt [illegible] mills	9.00
32-300 volt 60 mills	7.50

Prisms, Binoculars, Bausch & Lomb, used, slightly chipped, 1 11/16 inch long by ¾ inch wide $2.00

Bunnell Resistance Box 1 to 10,000 ohms. A beautiful piece of laboratory or test apparatus. Complete with plugs. $30.00

New ½ H.P. 2-phase 60 cy. 220 v. 3450 r.p.m. Westinghouse. $25.00

New 1¼ H.P. 1-phase 60 cy. 110 or 220 v. 3450 r.p.m. Diehl. Ball Bearing. $55.00

Motor generator, R & M 110 D. C. 3½ H.P., 2 kw. 20 volt 80 amp. $120.00

MOTOR GENERATORS

120 d.c., 110 or 220 a.c., 500 cycles, 250 watt.	$125.00 to $175.00
120 d.c., 110 or 220 a.c., 500 cycle, 500 watt.	$175.00 to $250.00
120 d.c., 110 or 220 a.c., 500 cycle, 1 kw.	$275.00 to $325.00
120 d.c., 110 or 220 a.c., 500 cycle, 2 kw.	$300.00 to $425.00
120 d.c., 110 or 220 a.c., 500 cycle, 5 kw.	$425.00 to $550.00
120 d.c. to 400 d.c. 2 kw.	$225.00 to $275.00
120 d.c. to 600 d.c. 2 kw.	$250.00 to $325.00

CONVERTERS

"Wappler X-Ray Co." 110 or 220 d.c. input—75 or 150 a.c. output.

½ KVA	$45.00	3 KVA	$95.00
1 KVA	$65.00	5 KVA	$110.00
1½ KVA	$75.00		

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Telegraph and buzzer portable sets, mahogany case, 2 tone 4 contact platinum point high frequency buzzer, 2 telephone toggle switches, potentiometer, sending key, 3 mfd. condensers, transformer and 2 choke coils, receiver. ...$10.00

Webster ¾" spark coil, 110 volt, 60 cycle 30 watts, with vibrator $5.00

Motors, Synchronous, 220 v. 60 cycles 1800 R.P.M. ⅛H.P. $30.00

Motors, Synchronous, 220 v. 60 cycles 1800 R.P.M. ½H.P. $60.00

U. S. N. double current generator, 450 volt at 250 mills and 9 volts at 3.75 amp. Complete with filter. May be used as dynamotor .. $55.00

MANHATTAN ELECTRICAL BARGAIN HOUSE, INC., Dept. S.S., 120 Chambers St., New York City

welding. Laboratory experiments indicate that an improvement of as much as 20 percent may be made in welding.

Deflection of the arc is caused by magnetic forces produced by the electric current as it passes through the electrode (or welding rod), the steel plate being welded, and through the arc itself, the engineers said, or it may be caused by permanently magnetized plates.

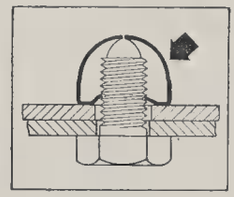
"The electric arc is a flexible gaseous conductor and the presence of external forces causes the arc to be distorted and even be extinguished," Mr. Jenning explained. "When the arc is deflected, the joining metal doesn't transfer properly to the desired location. We have found that re-routing the magnetic forces acting on the arc is an effective way to combat arc blow."

The horseshoe-shaped magnetic shunt is used in the case of heavy steel plates which are permanently magnetized. Made of two bars which are bolted together to provide a good magnetic path between the sides, this shunt is placed along the joint and changes the direction of magnetic forces in the work piece. When welding close to the end of a joint, a flat steel bar will serve as magnetic shunt.

SPRING NUT

Made in Acorn Shape, Is Self-Locking

EXTENDING inward from the base of a newly designed spring nut, now available in acorn as well as other shapes, is a series of fingers that sur-



Fingers formed in shell grip threads tightly

round the screw thread and grip on one thread in a self-locking assembly. A cross-section of one of these nuts, made by the Palnut Company, is shown in an accompanying drawing. This new unit, part of the company's line of formed steel nut and lock-nut fastenings, is available in three sizes.

PIER FORMS

For Casting Concrete, Made of Laminated Fiber

LAMINATED, spiral-wound, specially constructed and wax-treated fiber tubes are now available in five standard diameters for use as concrete pier forms. These tubes, furnished in

lengths up to 24 feet and in inside diameters from 9 to 13½ inches, are cut to length on the job, by hand or power saw, in a matter of seconds.

Such pier forms, known by the trade-name of Sonotube, are easy to handle, are easily set up in place, and need not be stripped off after the piers are set up.

GERMICIDE

Added to Cutting Oils,

Protects Workers

DEVELOPED to be used by adding to cutting oils, a new liquid germicide is now on the market under the name of Cutacid. Application of four ounces of the liquid in 55 gallons of cutting oil makes a solution that destroys germs, thus protecting workers who may receive skin abrasions and cuts while performing machining operations.

BRIGHT STEEL

Assured by Use of Conditioner

in Pickling Bath

A STEEL surface conditioner for use in either hydrochloric or sulfuric acid pickling baths results in a bright metal surface which is ready for immediate electroplating. It is claimed that the use of this surface conditioner, known as Surbrite, will reduce acid consumption and metal loss in comparison with pickling practices where plain acid is used.

NOTCHING UNIT

Maintains Punch and Die

in Alignment

WHERE metal parts require a notching operation for bending or forming purposes, a new unit has been made available which can be used with any press of suitable capacity. Nothing is attached to the press ram, the self-contained holder of the unit maintaining constant alignment of the punch and die.

These notching units, made by the Strippit Corporation, can be set up in series and standard or irregular notching patterns can be achieved in one stroke of the press ram.

Self-contained, cuts notches

UNIVERSAL VISE

Designed to Hold Work

in Any Position

THE time required for involved and complicated machine-tool setups can frequently be greatly reduced by the use of a universal type of vise which

Compound angles can be "dialed"

can be applied to drill presses, grinding machines, and other shop equipment. The most complex left and right compound angles can be produced literally by the twist of a dial.

Among the accessories available for this vise, made by the F. & H. Manufacturing Company, is a pair of friction plates joined together by a ball and spring socket. These plates are designed for instantaneous clamping of work pieces whose opposite sides do not lie in parallel planes.

TERMINAL

Solderless Type Assures

Durable Connections

A "PLUG TYPE" terminal designed specifically for use on panel boards and rotary switches, on shipboard—or wherever plug-in wire connections are demanded — assures a durable, solderless connection. Manufactured by Aircraft-Marine Products, Inc., these terminals are available in straight and right-angle shapes for wire sizes 16 and 14.

Easily installed—no special skill is required to crimp the terminal onto the wire end with simple hand, bench, or floor type crimping tools—the AMP "plug type" solderless wire terminal is

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LUMINOUS PIGMENT, ½ OUNCE mix with lacquer, shellac, varnish or gummed water. Will glow 4 hrs. before "re-exciting".

Both for **$1.00** *Postpaid*

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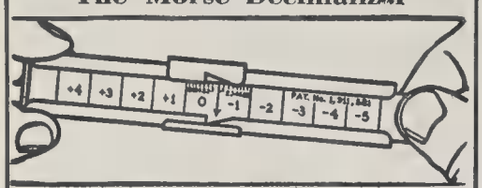
Lighting Engineers for 50 years.

The Morse Decimalizer



The DECIMALIZER shows in a few simple manipulations just where to place the decimal point in the result of any computation involving several elements, part or all of which may be decimals— for example, in such a problem as (9 x .0432 x 74.1 x 3.8) ÷ (245 x .0093 x 36). The DECIMALIZER removes that "decimal point hazard" inherent in computations made with the slide rule or otherwise.

Pocket size; durable (stainless steel); exceedingly smooth in action. Furnished in leather case, with complete directions for using. Price $2, postpaid; with extra, easily interchangeable scale which enables the instrument to perform extended multiplication and division, 50 cents additional. Money back, if returned within 10 days.

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A boon for elderly people and others with poor eyesight. Wonderful for doctors, scientists and draftsmen. Write for free information and details of this new invention that makes reading matter 3 times larger.

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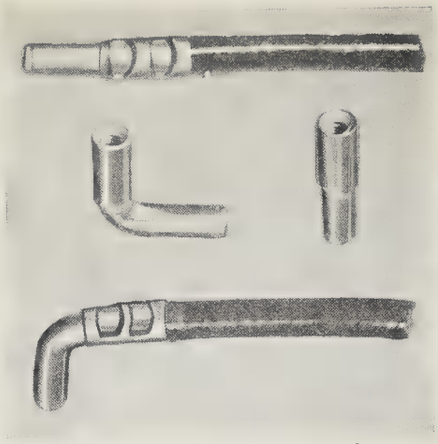


Straight and angle terminals

made of soft copper, annealed after fabrication to resist bending and breaking and hot electro-tinned for corrosion resistance.

FLAW DETECTION

Accomplished With Sodium Light and Microscope

SODIUM light, which has proved effective for highway lighting, is being used in several important war plants for surface inspection by microscope, because of its efficiency in the detection of pits, cracks, and flaws in materials. The sodium lamp is essentially an arc lamp, and differs from the incandescent in that it requires a special socket and individual control for each lamp.

The unusual perception of detail under sodium illumination is due to the monochromatic nature of the light, according to H. A. Breeding, of the General Electric Illuminating Laboratory. The eye, in common with other lenses, actually focuses only one narrow wave or color band at a time. Other colors in the beam tend to fog the picture. Thus, minute details may be lost in examining an object under a light which contains all wave bands, in contrast to an examination of the same object under monochromatic light which contains only one wavelength. Also, a given amount of energy from sodium light produces several times as much illumination as the same amount of energy in white light.

As in the case of sodium lighting for night safety driving, monochromatic light for microscopic inspection is most effective when spread uniformly over a large area rather than concentrated in small bright patches. In this way an undistorted view of both size and shape of flaws present is obtained. For most effective results, the level of the illumination should be comparatively high, especially when the contrast between flaw and surrounding material is low.

It is helpful in searching for cracks and blow holes to treat the part with either a light-absorbing or light-reflecting dye, the dye depending on the nature of the surface to be inspected. The dyed surface should be cleaned thoroughly before inspection. This procedure increases the contrast between flaw and object to the point where extremely small flaws can be detected. In all cases it has been found necessary to block out as much sunlight as possible, in order not to destroy the monochromatic nature of the sodium illumination.

NO SLIP

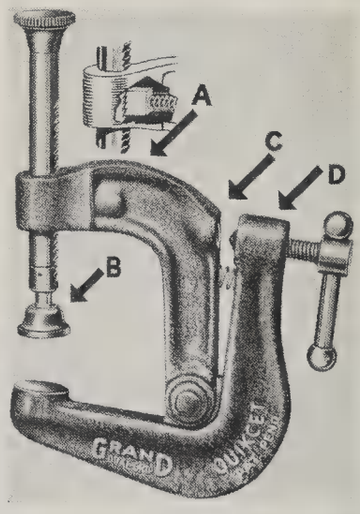
Safe Floor Surface Produced With Emery

A MIXTURE of large and small sharp mineral emery particles has been made available by the Walter Maguire Company for addition to Portland cement and water. This mixture, applied on a concrete surface to a depth of an inch, or more results in complete slip-proofing and a surface that will take heavy trucking wear.

CLAMP

Quick-Acting Design Holds On Straight, Tapered Surfaces

THE long screw of the standard type of clamp is replaced in the clamp shown in the illustration by a ratchet rod. In use, this clamp is placed in position, the ratchet rod is pushed down, and final tightening pressure is



Letters are referred to in the text; inset shows spring-loaded ratchet

applied by the short screw shown to the right in the illustration.

The clamp includes two parts hinged together in an arrangement that prevents slipping on tapered or irregular surfaces. In the illustration, A indicates the spring-backed pawl, B the replaceable swivel in the end of the ratchet rod, and C the point of application of pressure by the screw D.

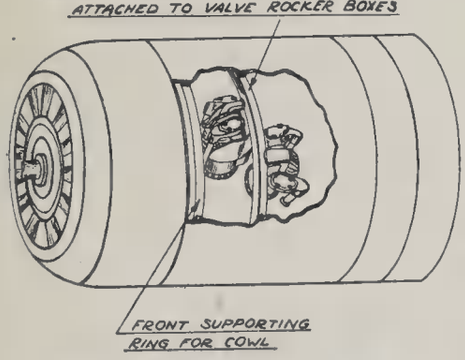
How Germany Does It

Powerful, Compact Airplane Engine Has a Pre-Designed Cooling System and Other "Built-In" Accessories

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

THE most powerful and probably the best air-cooled aircraft engines in the world are built in the United States, but there is a good deal to be learned from the German twin-row engine, the B.M.W. 801A, which has been described in *Flight* and other English technical journals. In the United States and in England we take an air-cooled engine and then fit to it cowling, cowling flaps, scoops, and other accessories. But the Germans have conceived the B.M.W. not just as an engine, but as a real power-plant unit, with pre-designed cooling and other accessories. As a result, the B.M.W. is surprisingly compact and clean, from an aerodynamic point of view.

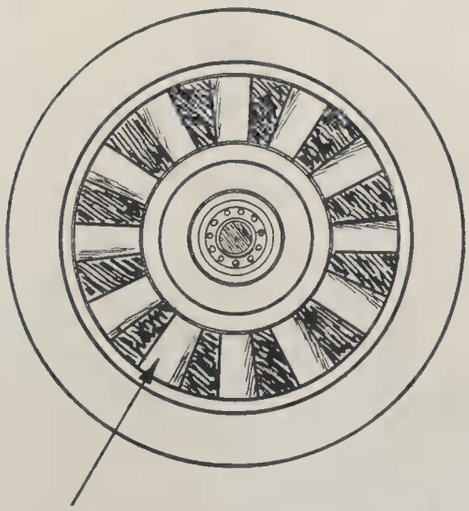
Within a diameter of only 52 inches and an overall length of only 58 inches, there is packed 1580 horsepower at take-off; 1460 horsepower at 16,300 feet of altitude, and 1280 horsepower at 18,500 feet. Of course, the B.M.W. has neither the power nor the altitude characteristics of the P & W engine that is scheduled to equip the Republic Thunderbolt, but the packing of so much power in so small a volume is



Partially cut-away view of the German B.M.W. engine, showing the cooling fan and two of the cowl rings

none the less remarkable. To achieve this small overall diameter the cowling encircles the 50-inch diameter engine closely. It is supported by front and rear rings and an inter-cylinder baffle ring, all attached to the valve rocker boxes by means of rubber-bushed bolts.

To make sure of cooling, particularly during the take-off period, the Nazi designers have introduced another innovation. At the front end of the engine the cowling is faired down to shroud a 12-bladed magnesium-alloy fan of 32 inches diameter. The fan is driven from the engine at nearly twice



Gearing doubles the fan speed

crankshaft speed, thus assuring an adequate air flow when the engine is running on the ground or in flight at slow speed. When the aircraft has a forward speed of 170 miles an hour, the fan is declutched and motored around by the air stream. At take-off there is a loss of 100 horsepower in running the fan, but this serious loss is more than offset by the positive air flow and the small-diameter, low-drag cowling. Exit of the air is by way of two circumferential slots controlled by a sliding ring and special mechanism gives uniform flow all through the engine and at exit. The air intake for the supercharger is completely inside the cowling and fed from the air delivered by the fan, which also helps in reducing head resistance. By this combination of means, a smooth exterior of low aerodynamic drag is attained.

Cylinders are arranged in staggered rows of seven each, with the lowest front and the uppermost rear arranged vertically. Details of construction are

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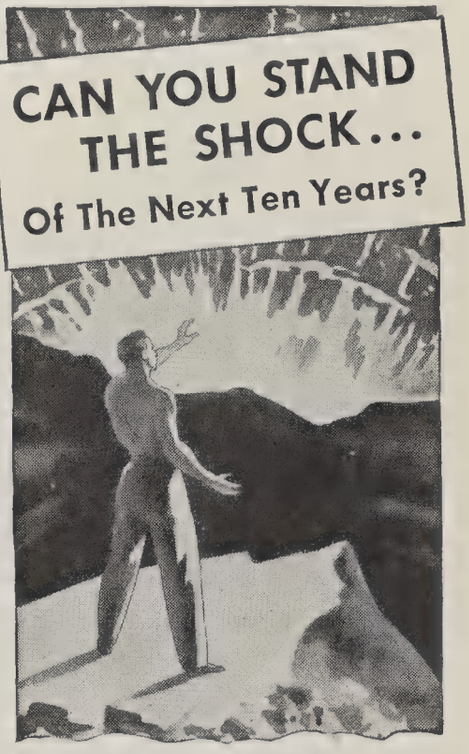

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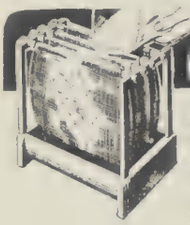

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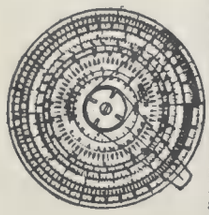

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interesting and the whole design appears thoroughly workmanlike. It is also interesting to learn that the exhaust pipes terminate in a flame damping fitting, but without shroud or screen to obscure glow.

There is, of course, a drawback to this compactness, coupled with inherent complexity, and inside the cowling there is a mass of pipes and accessories, which gives an impression of complexity and of difficulties in maintenance. But perhaps the Germans do not intend maintenance work to be carried out on the engine until the power plant is dismounted. At any rate, our designers would do well to study every bit of information that may be available.

FEAR AND HATE

Diminish and Increase With Continuing Air Raids

DR. V. L. GRUBERG, writing in the English magazine, *Flight,* attempts to reduce the psychological value of the air raid to a formula and plots the intensity of various psychological factors against time. His conclusion is that with repetition of the raids, the curve of fear gradually descends while that for hatred rises. Apparently Dr. Gruberg's belief is substantiated by studies of the Spanish civil war and other conflicts, that the air raid makes the civilian population hate so much that they are more determined than ever to continue the fight. That is precisely where the Germans made their great mistake. They thought they could reduce England by inducing fear in the civilian population and failed. The British are on far sounder ground because their raids are primarily for the destruction of war production establishments, and not for the killing of the civilian population, which is incidental.—A. K.

THE THUNDERBOLT

Saves for Weight, Compares Favorably with German Fw. 190

GERMANY'S latest single-seater fighter, the Focke-Wulf Fw. 190, of which we read quite frequently in the press, is equipped with the B.M.W. 801A, previously described in these columns.

The Fw. 190 is remarkably clean. Owing to the compactness of the engine, the fuselage does not show the somewhat "tubby" appearance which we note on fighters having engines of greater diameter. There is a total absence of excrescences to mar the beautiful lines of the ship. The Fw. 190 is powerfully armed with four cannons and two machine guns. But, what is more remarkable, is the compactness of dimensions. The span is only 34 feet, 5 inches; the wing area is only 194 square feet; the gross weight only 8580 pounds. With its powerful engine and relatively small size and its two-speed supercharger, the machine has a remarkable climb of 3000 feet a minute at a 4000 foot altitude, and at 18,000 feet, with the supercharger in high gear, the speed is 375 miles per hour.

With greater speed, greater ceiling, more powerful armament, and more power in its engine, our Thunderbolt is certain to be more than a match for the Fw. 190. But the Thunderbolt is also bigger, weighs 13,000 pounds, according to the New York *Times,* and is likely to be more heavily loaded per square foot of wing area. Our Thunderbolt will be immeasurably superior to the Focke-Wulf at great altitudes. At medium altitudes it will be faster and more powerful, but greater weight also means less maneuverability. We wish our Thunderbolt could retail all its fire power, all its armored protection, all its high ceiling characteristics, but be just a trifle lighter and more meneuverable for moderate altitude fighting. But, in all probability, other of our ships already fill the gap perfectly.—A. K.

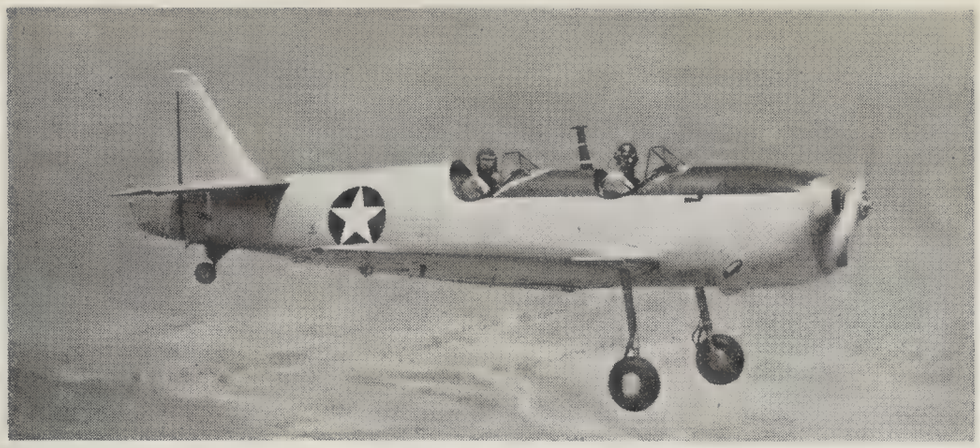
A GERMAN VIEW

Shows Striking Similarity in Research Work

SOMEHOW or other, belligerent nations secure each other's technical or scientific papers and study them with the closest attention. Thus, *Flight,* London, reprints with pride a paper on "Topical Aircraft Problems" read by Professor Dr. Ing. Gunther Bock before the Libenthal Society of Berlin, and in America the paper is hailed with the same eagerness as in London. Yet nothing very novel is discoverable. Apparently the Germans are thinking on similar lines to ourselves.

Thus, we have frequently mentioned in these columns that if the flow could remain laminar over the greater portion of the wing, the drag could be very much reduced, and that the path of progress lay in so shaping the wing as to make the suction more uniform over the upper surface of the wing, so as to delay change from laminar to turbulent flow. Professor Bock advocates exactly the same line of research. Another problem, according to the same German authority, is to eliminate the windshield and blend very large windows into a streamline form. Such practice also coincides with ours.

All the nations at war are seeking



No critical high-alloy steel in fittings or standard parts

greater power output than their enemies: Let us quote from the German authority: "This effort has led, in Germany, to going over from the carburetor engine to the injection engine. On its passage through the carburetor, the air is, as is well known, throttled and therefore energy is removed. In the injection engine the carburetor is omitted, and the fuel is injected direct into the cylinder on the induction stroke by special pumps. The throttling losses of the carburetor therefore disappear, and we obtain, by going over to injection, an increase in power output of 4 to 10 percent."

The no-thrust radiator is agitating the Germans just as it is us: "The air which passes through the radiator is heated and expands. On account of this, it leaves the radiator cowling with greater velocity than it would have in the case of a cold radiator. This increase in speed produces a thrust, as in the case of a rocket."

Considerable attention is given by the Germans, as by ourselves, to utilizing the exhaust gas energy for supercharging, and in general to utilizing exhaust gas efflux for producing thrust.

All of this reads remarkably as if one of our own engineers had read a paper before the Institute of Aeronautical Sciences. It indicates that technologists everywhere are apt to tackle the same problems at about the same stage of evolution.—*A. K.*

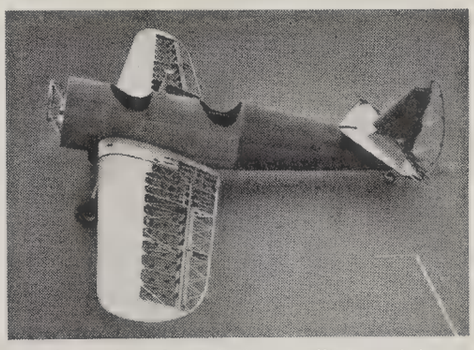
TRIM TRAINER

Ryan-built Plane Made of "Ersatz" Materials

THE Ryan PT-25 Military Primary Trainer is an excellent training plane, well adapted for its purpose in every way, and the result of many years experience in the construction of such aircraft. Powered with a six-cylinder opposed Lycoming air-cooled engine, it has speed and maneuverability. Both student pilot in the front cockpit and instructor in the rear cockpit enjoy excellent vision.

But what is perhaps more important at this time is the fact that the PT-25 dispenses with aluminum alloys and all other strategic materials, except those which appear in the cowling and, of course, in the engine, which could hardly be built of wood.

Moreover, the design is a splendid embodiment of the plastic-bonded plywood construction which is assuming such great importance today. The smoothness of line has been obtained with a minimum of compound curved surfaces, so that a manufacturing



Plywood and other "ersatz" materials play a big part in wings and fuselage

method is employed which does not require the use of ovens or baking, and cold-setting urea formaldehyde glues are used throughout. The fuselage is of the monocoque stressed skin type with ten bulkheads formed of laminated spruce, and is plywood covered. Although well streamlined, the fuselage has such lines that manufacture is easy. A unique jig allows the workman to go inside the jig and unbolt the holding forms after fabrication, so that all that is then necessary is to slide the completed section off the jig. One of our photographs shows a view of the wing construction. Each wing panel is built up from a single wood spar with wood ribs and a plywood-covered nose torque box. Fabric covers the rest of the wing. This type of construction reduces labor to a minimum and, because the weight of the wing is far forward along the chord, flutter is not likely. The simple construction is apparent from the photograph.—*A. K.*

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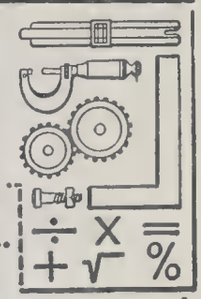

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CAMERA ANGLES

Conducted by JACOB DESCHIN, A. R. P. S.

Your Town in Wartime

KEEP a picture diary of the changes going on in your town during the course of the war. It will be a valuable historical record not only for your own family and friends but, if well done, for the town itself. For example, this shot was made in Provincetown on Cape Cod, where the war has had a marked effect on the pattern of the town's life and ways. A Coast Guard training station

"Them Coast Guard Fellers"

there has made Coast Guardsmen part of the regular population and restrictions due to wartime necessity have limited the fisherman's choice of fishing areas. Something of the natives' reaction to the change has been caught in this picture.

Greeting Card Time

CHRISTMAS is on its way again and greeting card making is in order. This year greeting cards are more important than ever, particularly for the boys in the camps, and pictures will be appreciated by the fighting men more keenly. For the boys farthest from home and unable to get away for long enough periods to make the round trip to home and back to camp, pictures of family and friends will have a real meaning, like a visit from the folks. Whereas formerly a decorative scene of some sort did the trick fairly adequately, this year send faces.

Expose Color for Shadows or Highlights?

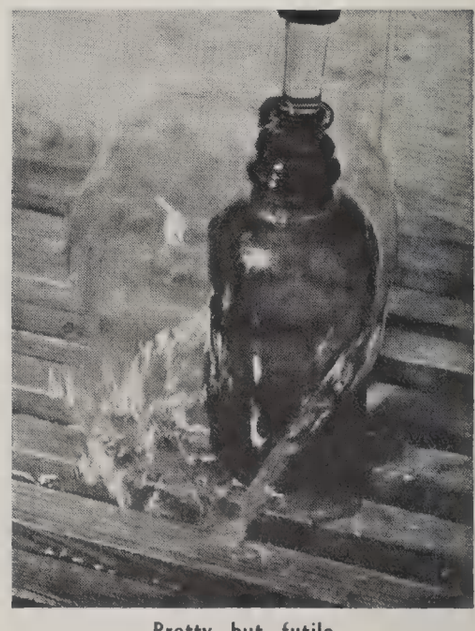
THERE was a rule once, that seemed as fixed as fate, that one should expose for the shadows and let the highlights take care of themselves. Today, some doubt the accuracy of this and in certain quarters it is even suggested that we should expose for the highlights instead. However this may be for black and white, in color, where the range of illumination should never exceed four to one for reasonably good color rendition, it is advisable to read the highlights. If we were to expose for the shadows in Kodachrome, our highlights would be washed out; if we expose for the highlights, the shadows are rendered satisfactorily enough. The one exception to this rule might be the occasion when the shadows predominate and the highlights occupy only a small part of the scene. Then, obviously, our shadows should get the major attention and the exposure meter should be directed toward them to obtain the proper exposure.

Lantern-Slide Lectures

NOTHING can teach a fellow how to make better pictures so well as the constant observation of prints that have won salon recognition time and time again. Realizing this, the Metropolitan Camera Club Council, of New York, has instituted a project under the direction of C. T. Boyles, A.R.P.S., designed to provide camera clubs with lantern-slide lectures showing reproductions of prints that have been hung in outstanding American photographic salons. Constructive criticism will accompany the prints. The photographing of the originals was done by J. Ray Hoagland, first vice-president of the Council, and Ernest F Draper, technical advisor.

Efficient Washing

LOOKS pretty, but is it efficient? Of course not. The illustration is an exaggeration, naturally, but have you ever noticed how careless some folks are about washing roll film in tanks? They let the water run in from the faucet and hope that somehow, willy-nilly, the films will get washed. The water has to get straight



Pretty but futile

to the bottom of the tank and with enough force to drive the hypo out. The only way to do this effectively is to use a hose let down to near the bottom of the tank. The water will then force the hypo up over the top of the tank and out.

Copying Rough Prints

PRINTS on rough or matt surfaces are difficult to copy because the results usually show the texture of the paper, making the copy a rather unsatisfactory job. One suggestion to avoid this is to rub the print down with a good coating of petroleum jelly (white Vaseline). Apply the coating evenly. Illuminate the print so that reflection is prevented and that even illumination is produced. The grain is greatly minimized if not eliminated entirely. The glazing action over the paper texture does the trick

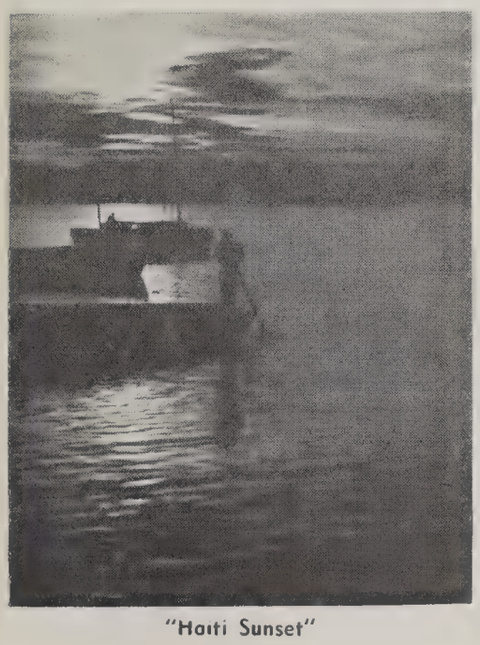
Comparing Lens Apertures

HERE'S a handy table (Bell & Howell) which both movie and still fans should find useful. Comparing aperture *f*/2.5 with *f*/3.5, for example, we find that the coefficient of *f*/2.5 is .06; that of *f*/3.5 is .12. The latter being double the former, the *f*/2.5 aperture is twice as fast as *f*/3.5. Figures starred represent the true, full stops, each of which admits 100 percent more light than the next smaller true stop. For all practical purposes *f*/1.5 is equal to *f*/1.4, and so on:

Coefficient of Illumination	F Stops	Coefficient of Illumination	F Stops
.01	*1.	.30	5.5
.02	*1.4	.31	*5.6
.03	1.7	.40	6.3
.04	*2.	.64	*8.
.06	2.5	1.21	11.
.07	2.7	1.28	*11.3
.08	*2.8	2.56	*16.
.12	3.5	4.84	22.
.16	*4.	5.29	*23.
.20	4.5	10.24	*32

Sunset Silhouette

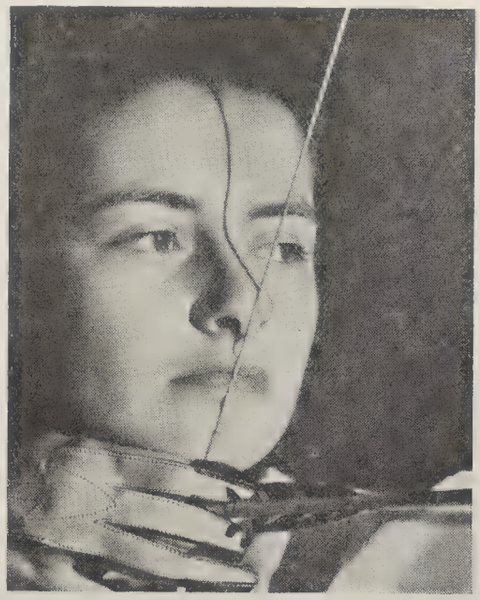
ONE of the reasons for the failure of many sunset pictures is the lack of interesting foreground material. Choose a viewpoint where you can include part of a boat, the wharf, or some other object, place it appropriately in the picture area, and you have something far superior to the mere sunset shot, which includes only sky and water.



"Haiti Sunset"

Record Into Pictorial

THERE'S no law that says a record shot made for the sole purpose of illustrating a fact cannot also serve the uses of pictorialism. Take, for example, the picture of the girl drawing the bow string. This was one of a series of pictures made



For record and salon

to illustrate the technical details of archery. Most of the pictures in the project were useful only as part of the complete set, but here and there opportunities presented themselves for special pictorial treatment. A print such as this, for example, can be finished off in salon style, with toning and all the fixings.

Prints on China

HERE'S an idea for those who have been wanting to print a picture on china or glassware. Chromatone Stripping Paper, ordinarily employed in color printing, will serve for black-and-white printing as well. Make your print as usual, strip the emulsion from the base, then fix and wash as you would when making ordinary prints. Apply a coating of gelatine to the china, glass, or whatever, then mount the print. When perfectly dry, cover with a coat of clear waterproof varnish.

Pictures for Reproduction

A FAVORITE method with engravers in judging how a print will reproduce in a publication, is to look at the print with eyes half closed. This compresses the tone scale and reduces the values to somewhere near the tone range that can be expected in the reproduction. Delicate differences between highlights, for example, tend to merge into a single tone, indicating that a new print should be made to show more contrast.

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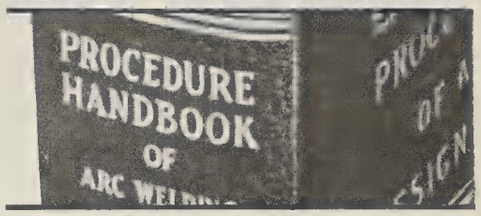

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Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

IN THIS department, in our September number, we showed a photograph of the huge worm wheel for the R. A. drive of the 200″ telescope. Through the courtesy of *Modern Machine Shop,* Cincinnati, we make available to our readers an account, written by Robert Clark, of the exceedingly refined and prolonged job of cutting the teeth on the gear within a tolerance of one second of arc (1/1,296,000 of a circle).

Only once in the history of gear cutting has there been any record of the cutting of a worm gear weighing ten tons, having 720 — ¾-pitch teeth within an overall tolerance of 0.0001″. To three men go the credit for this feat; Mr. G. Sherburne, Superintendent of the Astrophysics Machine Shop at the California Institute of Technology, and his assistants, Mr. Tom Weir and Mr. Lawrence Sills, machinists.

The gear, one of three identical gears cut, is used to drive the mechanism which positions the 200″ telescope.

The architect's drawing (Figure 1) shows a cross-section of two of the gears which are employed to position the telescope in right ascension. One of the gears makes it possible to move the telescope quickly in making a setup; the other is the final gear in a set which swings the telescope at the exceedingly slow speed required to follow a star.

The drive gear, which is 14′3″ diameter, is of cast iron with 0.25 percent of molybdenum added to give it the necessary 200 Brinnell hardness.

One of the initial problems was the design of a support for the blank which would make it possible to keep the side play down to the error allowance of 0.0001″ while the teeth were being cut. The first job, then, was to construct a bearing and spindle that would meet these requirements. This was done by machining the spindle so that it had two tapered surfaces—one near the top, the other near the bottom—that were lapped into two tapered bearings which were made to take them.

A small pilot shaft at the end of the spindle rested on a special thrust bearing which could be adjusted. By slightly raising the spindle and gear, the coefficient of friction could be lessened to prevent the spindle from freezing in its tapered bearings, although, even with this setup, the matter of lubrication to the spindle caused considerable trouble. Even the lightest oil film would permit side play of more than 0.0001″. Indeed, the capillary action of the light oil was sufficient to raise the spindle, gear, and structure—weighing more than 10 tons— as much as 0.0001″. The vertical movement was not of much importance, but the side play was. However, by the expedient of machining facets in the tapered sections of the spindle, the error caused by the oil film was eliminated to within the tolerance allowed.

Adequate temperature control could be obtained only by the construction of a room about the whole job. Air conditioning equipment was then installed, with which the temperature of the room could be controlled within plus or minus 1° F. When ready to run, the room temperature was maintained at 74° to 76°.

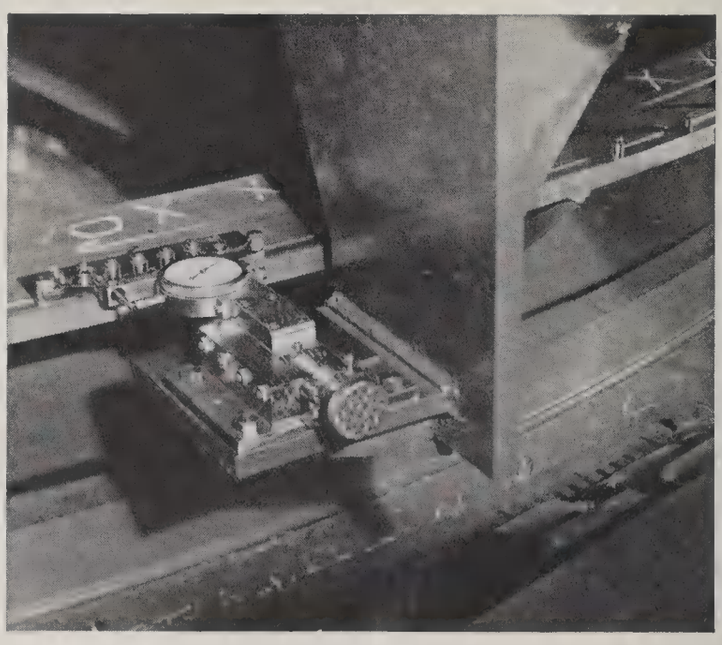
Calculations that had been made showed than any equipment for indexing, if placed upon the gear blank itself, would develop a warping action due to the stresses set up by the cutting, and thus would ruin the accuracy of the job. To eliminate this difficulty, an auxiliary plate of approximately the same diameter as the gear was made and securely bolted to the blank so that measurements could be taken from it for the milling operation.

In order to space the teeth properly, buttons of hardened tool steel, ground to within 0.0001″ of a given size, were mounted on the plate. Dial gages were then used to ensure perfect location.

[Note by Ed., Scientific American.— These "buttons," from here on frequently referred to, are the "toolmakers' buttons" which are familiar to mechanics. Whenever high-precision accuracy in the positioning of a cutting or grinding operation is called for, methods such as making marks by ordinary measuring are not sufficiently close. There must be some additional method of "correcting the aim" by a series of closer and closer approximations. This is done by the use of "toolmakers' buttons." First, the point is determined as closely as possible by ordinary methods. A center-punch mark is made and a hole is drilled and threaded. The button, a small steel cylinder (several of which show in Figures 2 and 4) having a vertical, central hole, is then attached by means of a machine-screw.

Figure 1: Left: The drive in right ascension

Figure 2: Right: Positioning the teeth with buttons



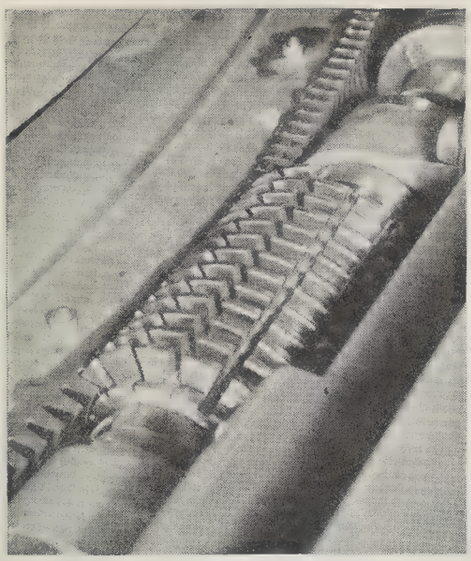


Figure 3: Cutting the teeth

The hole in the button is purposely made larger than the machine-screw, so that the button will have side play. If, now, the screw is adjusted just snugly, but not too tight, the button may still be shifted in position within small but sufficient limits. This is done by delicately tapping on its side with a light tool. When the final measurement, made in the present instance by means of a long tram rod, or trammel, indicates that the button is positioned as closely as possible, the screw is set up, and the machine is adjusted to cut in relation to this button, the button itself being then removed to permit completion of the operation. Since the dimension of the button enters into the measurements and calculations, this must of course be accurately known.]

The process of locating the buttons on the button plate presented some interesting problems. The placing of the first one was, of course, easy, but locating the second one, which was to be 180° away, was another matter. All the buttons were mounted on an eccentric, which allowed them to be adjusted slightly. The second button was roughly located with the aid of a straight-edge lined up across the center of the plate to within perhaps 0.004″ to 0.005″. Then the slow, tedious task of adjusting the buttons at points exactly 180° apart, within 0.0001″, began.

Two dial indicators graduated to 0.0001″ had already been set up 180° apart, positioned on ground ways. The first indicator was adjusted to the leading edge of the first button, and set to read zero. The second indicator was then set on the second button and set to read zero. Then the gear was revolved 180° and new readings were taken. Of course, the readings were off.

The buttons were then adjusted to compensate for the error, as closely as it could be judged, and the gear was revolved again. The error was less the second time, but still over the allowable limit. Again the buttons were adjusted and again the gear was revolved the 180°. After many more trials and adjustments, the buttons were spaced within the allowable limits.

Now came the problem of locating the second set of buttons at the 90° positions.

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The exact spots for these buttons had been determined by calculations and a tram rod had been made to measure the distance from the first two buttons. From the calculations the buttons for the 90° positions were set to within 0.004″ or 0.005″. Then the tram rod was used.

At one end of the tram rod was a hardened "V," made to fit the buttons. At the other end was a dial gage, reading to 0.0001″. The tram was well insulated by wrapping it with paper, and a wooden handle had been incorporated into the construction so that the heat from the machinist's hands would not introduce errors in the readings. Just one degree of temperature shift was found to change the reading as much as 0.0002″.

The next move was to adjust the two buttons in the 90° positions so that, by using the tram in any one of the four quadrants of the gear, the error was brought within the allowable limits. This process was repeated with another tram for the 45° positions of the third set of buttons, and other trams of the correct lengths were used until all of the 144 buttons had properly been spaced on the plate. This allowed a button for every fifth tooth on the gear. When the time came for milling the intermediate teeth, an insert of four buttons, shown in Figure 2, was used.

With all the buttons properly located, it was time to cut the first gash. Then the gear was revolved 180° to eliminate accumulated error, and the second gash was made. Then to the 90° position, and so on. The rough milling was done in two stages, taking two straight cuts and leaving 0.007″ in the second cut to be removed by the hobber in the finishing cut. The hobbing operation is illustrated in Figure 3.

It was found that, during the milling, the heat generated by the cutter materially affected the accuracy of the operation. To relieve this situation, a hollow cutter arbor was used through which water at a controlled temperature could be circulated.

After the first roughing cut had been made for all 720 teeth, the method of checking for accuracy was changed. A microscope was anchored in position over the handwheel of the worm, which was graduated in 0.0001″, and a dial indicator was positioned so that it would touch a tooth some distance away on the periphery of the gear as shown in Figure 4. As the gear was always revolved in one direction only, no correction was necessary for backlash. Upon checking and rechecking it was found that the error between any one tooth and any other was only 0.0001″.

When the gear blank was made, it had been split horizontally, with the idea that the two sections could be unbolted after the rough milling had been completed, so that the top section could be revolved 180° before the finishing cut was taken. This would, of course, have increased the accuracy. However, by using the method and care described above this action was rendered unnecessary.

The milling operations took ten months and the finish hobbing operation took three weeks. Two and one half years in all were required to cut the teeth on the three gears. As the work progressed from one gear to the next, the accuracy improved. For instance, in the cutting of the first gear there was an error in one of the quadrants of 0.0004″. This error made that particular quadrant unusable. However, the three remaining quadrants were within the allowable tolerance and this gear is now used for the North and South declination with the bad quadrant at the top of the gear where it is never used.

This completes the abstract from Robert Clark's account of the job for the 200″. In referring to Figure 1 he terms it "the architect's drawing," which is quite correct, but the architect happens to be Russell W. Porter. At that, Porter is an architect—or was so educated.

Those who have *created* a setting circle—that is, not simply taken off the marks from another divided circle or transferred them from gear-tooth spacings (which is about the same thing) but who have themselves divided a circle out of the void and nothingness, will recognize the almost exact similarity of the method employed with the method described above. The following is a short additional note written for the most recent printing of "A.T.M.A." and inserted on page 302. It briefly explains this method of creating a setting circle, and incidentally may be clipped out and pasted in earlier printings of "A.T.M.A." by those who own that book. It runs—

"Editor's Note: For theoretical data on setting circles, see chapter on 'The Divided Circle,' in Martin's 'Optical Measuring Instruments.' Also see article on

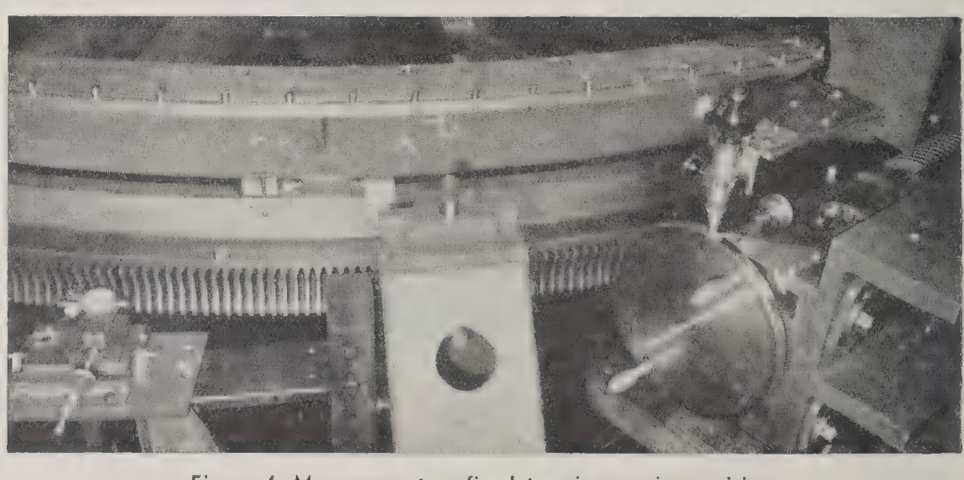

Figure 4: Measurements refined to microscopic precision

Divided Circles,' in Glazebrook's 'Dictionary of Applied Physics,' Vol. IV. The latter explains the methods used in one example chosen, for inscribing 4320 divisions, one for each 5 minutes of arc, on a 48" circle, within an accuracy of ½ second. The method is one of trial and error in a series of closer and closer approximations.

"A crude suggestion of the principle used can be had by tacking a circle of cardboard at its center to a board. Place a reference mark (representing the cutter) on the board adjacent to the edge of the circle and mark the periphery of the circle in continuation of it. Call this zero. Select the 180° point on the circle by approximate estimate. Make a tentative 180° mark, and continue it on the board. Now rotate the circle till the 180° mark lies next to the cutter. The true 180° point should now be halfway between the rotated zero mark on the circle and the nearby mark on the board.

"Estimate new marks for a closer trial and repeat the cycle; and so on.

"Using this as a starter, in the example mentioned above, the 90° and smaller divisions on the 48" circle were filled in by similar principles, and it all required six months of tedious slavery for the 4320 divisions. The approximations soon fell within the field of compound microscopes powerful enough to detect errors of one tenth second, or 1/86,000 inch.

"Gluttons for this general type of masochism will find in the same volume of Glazebrook a 10-page article on 'Diffraction Gratings, the Manufacture and Testing of,' by Dr. J. A. Anderson. Asked how the two jobs, the 48" circle and the construction of a ruling engine, would compare in difficulty, Dr. Anderson stated that the ruling engine job would be far more difficult, since so many more factors enter into it—not alone equality of spacing, but length and parallelism of grating lines."

End of "A.T.M.A." supplementary note.

This is not to say that the circle job is easy, and similarly for the big worm wheel job, but only that the ruling engine job is super, hyper, ultra. The other jobs are merely super, hyper.

EXCHANGE: From Peter Dawson, Care Dr. A. C. Ainsley, Greylands, Victoria Road, West Hartlepool, County Durham, England, comes the following: "Could you find two or three young fellows, at about the same stage as me in telescoptics, to correspond and keep the interest aglow, now that the difficulty of obtaining materials over here is increasing. I am only a very green amateur, aged 18, and my interest began three years ago. During this time I have been studying physics (with particular accent on optics) and hope to go to University to continue, in October. I have completed a 2½" refractor, the O.G. of which I did not work—I just did the engineering and woodwork. I have started a 6½" mirror and am at present grinding. I have studied that excellent book 'A.T.M.,' also 'A.T.M.A.' I am also a keen trout fisher. Do you think you could wangle it so that my correspondents are cursed with this plague too?"

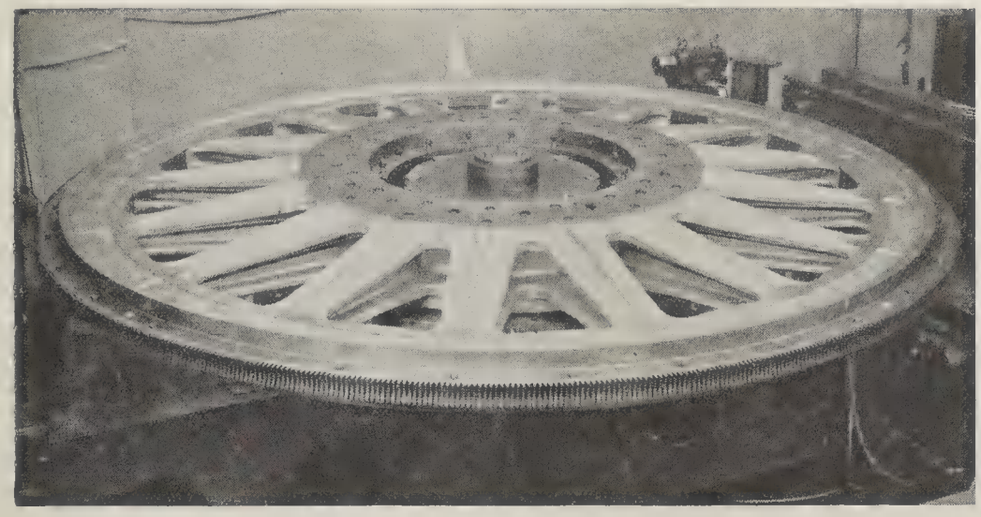

Figure 5: **The finished gear with 720 teeth of ¾ pitch**

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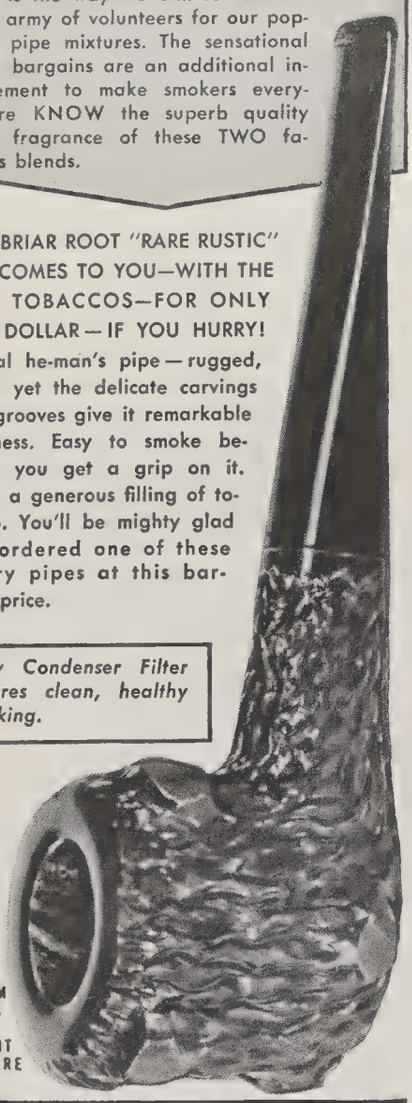

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REPLY TO BEWILDERMENT, by A. W. Robertson, is a 16-page discussion of democracy and the nature of wartime leadership. The text is the answer to a letter received by the author, in which a request was made as to the definition of the duties of patriotic Americans. *Westinghouse Electric & Manufacturing Company, 306 Fourth Avenue, Pittsburgh, Pennsylvania.—Gratis.*

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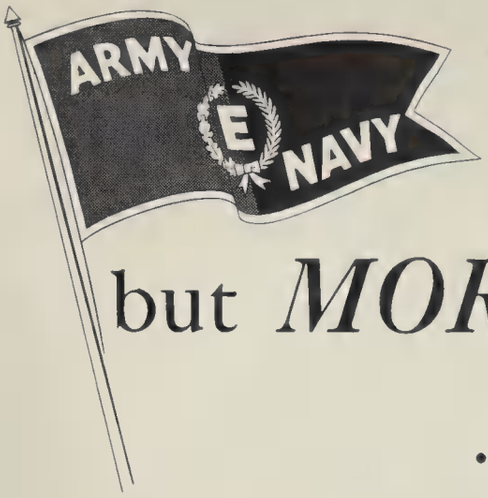

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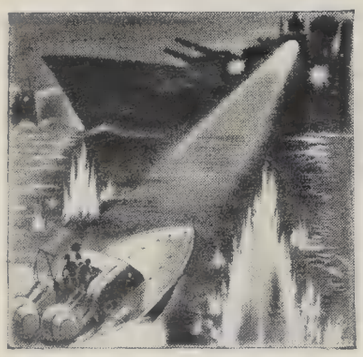
FROM time to time the judges of the Book-of-the-Month Club choose a double selection—two books offered to members at approximately the price of one. *They Were Expendable* has been hailed as the first great story to come out of the war—the tragic epic of the Philippines as told by four survivors of the heroic MTB Squadron 3. *The Seventh Cross* is a breathtaking novel of escape, "unlike anything that has come to us from a Europe under the shadow of darkness and fear." Our judges have introduced to American readers many of the most important European writers—Sigrid Undset with *Kristin Lavransdatter,* Arnold Zweig with *The Case of Sergeant Grischa,* Felix Salten with *Bambi*—and many others. Anna Seghers surely belongs in this category. The two books together are being sold to Club members for $3.00.

SQUADRON 3 consisted of six little boats—about a dozen men to a boat. Each boat was armed with four torpedo tubes, four 50 caliber machine guns. There isn't an ounce of armor steel on these boats—they're little eggshells made of plywood, powered by three Packard motors, designed to roar in, let fly a Sunday punch and zigzag out to dodge enemy fire. Yet between December 7th and the end of February they sank a hundred times their own combined tonnage in enemy warships. For every man in the combined crews, they had already probably killed ten Japanese. Their casualties to date were only one man, wounded. They were to lose more later, but the Japs were to pay at almost the same ratio.

Suddenly five Jap bombers dive at the three torpedo boats commanded by Lt. John Bulkeley. Bulkeley's men begin circling and twisting. They pick out a plane, pour 50 caliber slugs into it until it crashes. The 31 boat gets two more. After this the planes don't bother strafing MTB boats.

Kelly, the squadron's second in command, gets bad strep infection in his arm, and is ordered to army hospital on Corregidor, where his irrepressible high spirits make him a pet of the nurses. They call him their one-man morale officer. And when Peggy, with a choice of 10,999 men on the Rock, turns down a party and spends New Year's Eve with Kelly, sharing two apples and a box of marshmallows, it's the best New Year's Eve Kelly has ever had.



Bulkeley in PT41, Kelly in PT34 surprise a big Jap cruiser. Although caught in her searchlight and a continuous stream of fire, Kelly gets two direct hits. The cruiser's magazines explode, she soon sinks. Four destroyers now chase the PT boats but both finally get away, not without casualties.

Looking like a Spanish pirate, black-bearded Bulkeley commands the PT41 taking General MacArthur and his family from Corregidor. Without navigation instruments or chart they roar along at full speed through pitch blackness. Always there is the menace of lurking Jap destroyers and dive-bombers. Yet the mission is safely completed.

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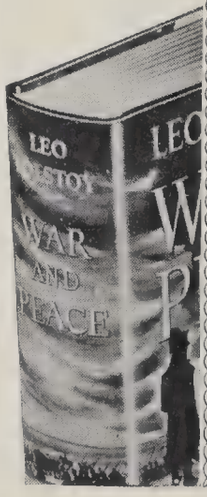
By LEO TOLSTOY

In this edition, Clifton Fadiman has written a critical interpretation of the novel and an analysis of the present-day significance of *War and Peace.* It includes maps which strikingly illustrate the parallel between the Napoleonic and the present invasions of Russia, and show the principal battles and places mentioned in the text. A valuable enclosure is provided for the reader's guidance, which contains a full list of the characters in order of their appearance, and also a chronological table of the principal historical events from 1805 to 1812.



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